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VOLUME 65 [W. B. No. 1205] NUMBER 3

MONTHLY WEATHER REVIEW

MARCH 1937

CONTENTS

UNITED STATES DEPARTMENT OF AGRICULTURE

WEATHER BUREAU

WASHINGTON, D. C.

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CORRECTIONS

Volume 65, January 1937, page 11, first column, second line from bottom, "miles" should be "meters"; page 41, table 3, LATE REPORTS, Toronto, precipitation departure "+4.8" should be "+.48".

See also corrections in "River and Flood" section on page 123.

February 1937, page 63, in the bold-face note just above the heading of table 3, "See p. 430 of the December 1936 REVIEW" *should read*, "See p. 61 of this REVIEW".

MONTHLY WEATHER REVIEW

Editor, EDGAR W. WOOLARD

Vol. 65, No. 3
W. B. No. 1205

MARCH 1937

Closed May 3, 1937
Issued June 8, 1937

TOTAL SOLAR AND SKY RADIATION ON MOUNT WASHINGTON, N. H.

By Bernhard Haurwitz

[Blue Hill Observatory of Harvard University ,Milton, Mass., December 1936]

When the Mount Washington Observatory [1] was reestablished in 1932, a pyrheliometer and recorder, of the standard type used by the United States Weather Bureau [2] were loaned by the Eppley Laboratory, Inc., of Newport, R. I., for the measurement of the total radiation from sun and sky on a horizontal surface.[3] The pyrheliometers which were used until March 1935, had 50 junctions.

Records were started on November 6, 1932. They were interrupted, however, by wind and lightning damage to pyrheliometer or recorder, in January 1933, and from the last of June to early in October 1933. The number of daily records for each month which could be used to compute the monthly averages in table 1 is rather small during this period, partly because no records were made on very stormy days, and partly because of other deficiencies. With occasional interruptions, as noted in table 1, observations were carried on until November 1935, when they were discontinued after the pyrheliometer had been broken in a gale.

In winter the bulb of the pyrheliometer was frequently covered with rime. This rime cover was usually removed from the bulb once or twice a day, and the time of removal noted. The removal is noticeable on the record as a sudden rise of the recorded radiation intensity, especially on clear days. It does not seem possible to take into account the loss of recorded solar radiation due to rime and frost deposits. The only possibility would be to smooth out the sharp rise in the radiation curve at the time of the rime removal. However, the time when the rime first formed is not known, and it is impossible to tell where the curve corrected for rime should begin to deviate from the recorded curve. Therefore, no corrections for rime have been applied. No attempt to prevent rime formation was made. It is doubtful if such methods as have been described by Lauscher [4] and Grundmann [5] would be of help under the severe conditions on Mount Washington.

The records were sent to Blue Hill Observatory at the end of each month. Here they were evaluated by Messrs. R. F. Baker, H. Wexler, S. Pagliuca, A. A. McKenzie, and the author. In the evaluation, each day was subdivided into intervals of 20 minutes; for these intervals the mean ordinate could be estimated without difficulty in most cases. The results are given in table 1, and figures 1 to 7. The time used is apparent time.

The highest average daily total occurred in May during 2 (1933, 1934) of the 3 years for which observations are available; while at Blue Hill, in 1933, the average daily total had its maximum in June [6] (table 2). In 1935, on the other hand, the radiation on Mount Washington was highest in June. During each year the radiation was lowest in December, as was also the case at Blue Hill in 1933. However, in January 1935, the radiation was exceptionally low, lower than for any other month. If we compare corresponding months, we see that in 1934, the radiant energy received at Mount Washington was markedly higher than in 1933 or 1935. Only the average daily total in November 1933, exceeded that of November 1934, by 39 gr cal/cm²; and the value for January 1933,

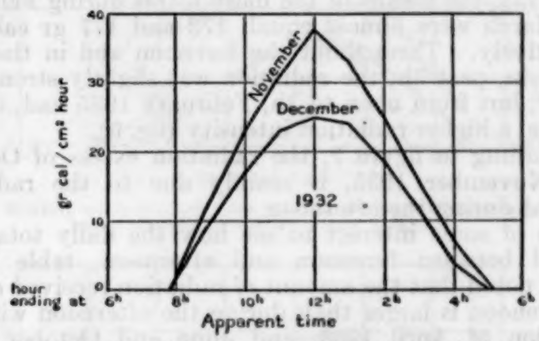

Figure 1. Monthly means of hourly sums of total radiation on a horizontal surface at Mount Washington, November–December, 1932

is higher than January 1934. The records for November and December 1932 show that during these 2 months the mean monthly daily total was higher than during the corresponding months in the following years for which data are available. Particularly low was the total radiation during the spring and early summer of 1935.

A comparison of the radiation received at Blue Hill and at Mount Washington during 1933 (cf. table 2) shows that through the year more energy was received at Blue Hill than at Mount Washington except in January, April, and May, when the average daily total was lower at Blue Hill than at Mount Washington. Neglecting the small difference in latitude, the influence of the higher altitude of Mount Washington which would tend to increase the radiation is evidently more than counterbalanced by the greater cloudiness and fogginess on the mountain.

Figure 1 shows that the diurnal rise to the maximum during November 1932 is much steeper than in December. During the noon hours the radiation energy was markedly greater in November than in December.

[1] For general descriptions of the Observatory see: R. S. Monahan and S. Pagliuca, The Mount Washington Observatory, Trans. Amer. Geoph. Un., 1933, p. 85; S. Pagliuca, Mount Washington Observatory, N. H., Progress Report, 1933, Monthly Weather Review, Jan. 1934, 62: 16–18, 5 figs.; A. A. McKenzie, The Mount Washington Observatory, 1934–35, Bull. Am. Met'l. Soc., March 1935, 16: 90–93. The geographical position of Mount Washington is 44°16′ N. lat. and 71°18′ W. long.; its elevation is 1911 meters above sea level.

[2] Pyrheliometers and pyrheliometric measurements, Weather Bureau circular Q, Washington, D. C., 1931.

[3] The pyrheliometer, on a wooden pillar set in a pile of rocks about 20 meters from the Observatory building, is shown in the photograph reproduced in the Monthly Weather Review, vol. 63, January 1934, fig. 5, opp. p. 17. There was no obstruction to the direct solar radiation, and only a negligible part of the lower sky was obscured by other buildings on the summit. The recorder was placed inside the Observatory building.

[4] F. Lauscher, Über ein Hilfsmittel zur Verhütung von Reifansatz an Sonnenscheinautographenkugeln, Met. Z., vol. 49, 1932, p. 112.

[5] W. Grundmann, Verhütung von Reifansatz an Sonnenscheinautographenkugeln und Aktinographenschalen, Met. Z., vol. 50, 1933, p. 194.

[6] B. Haurwitz, Daytime Radiation at Blue Hill Observatory in 1933, Harvard Meterological Studies, No. 1, Cambridge, 1934.

In January and March 1933 (fig. 2), the hourly radiation sums are equal, and in February only slightly smaller in the noon hours. The 11 gr cal/cm² per day by which the average daily totals in February exceeded January were received in the forenoon and late afternoon. The same is true for the radiation surplus in March. In April and May the radiation is very much higher during the noon hours. From June to September 1933 no hourly values are available.

In October and November 1933 (fig. 3), the average radiation intensities are equal in the morning hours. Thus the greater daily total in October is to be attributed to the higher radiation during the afternoon. The hourly radiation in December 1933 is less than that of November 1933, throughout the day.

During January 1934 (fig. 4), the radiation is much lower than in February 1934. In agreement with the fact that the average daily total is higher in May than in June 1934, the average hourly radiation intensity in May is the greater except in the forenoon and the evening, when June shows slightly higher values. For the hours ending at 11h and at noon, the June values are even exceeded by April; but in the earlier forenoon, and, to a lesser degree, in the afternoon, the radiation is more intense in June than in April 1934.

Figure 5 shows that in August 1934 the mean daily radiation had its maximum in the hour from 10h to 11h, while in November 1934 it was in the hour 12h to 1h. The reason for the occurrence of the August maximum in the forenoon may be the cumulus clouds which frequently shaded the summit about noon.

In 1935, the means of the daily totals during February and March were almost equal, 172 and 177 gr cal/cm², respectively. Throughout the forenoon and in the later afternoon, past 3h, the radiation was slightly stronger in March; but from noon to 3h, February 1935 had, on the average, a higher radiation intensity (fig. 6).

According to figure 7, the radiation excess of October over November 1935, is mainly due to the radiation received during the afternoon.

It is of some interest to see how the daily totals are divided between forenoon and afternoon, table 3. It will be noted that the amount of radiation received during the forenoon is larger than during the afternoon with the exception of April 1933, and June and October 1935; while during March and May 1933, the radiation is equally divided between forenoon and afternoon. Especially remarkable is November 1933, when 62 percent of the daily total was received during the forenoon, a condition paralleled at Blue Hill with 60 percent. April, May, October, and December 1933 also show a certain parallel between a. m. versus p. m. percentages.

TABLE 1.—*Monthly, hourly and daily means of total radiation on Mount Washington, N. H. in gr cal/cm².*

Month	Number of days[5]	Mean hourly totals during hour preceding: 5h	6h	7h	8h	9h	10	11	12	1h	2h	3h	4h	5h	6h	7h	8h	Mean daily total
1932																		
November	16	---	---	---	2	13	23	31	38	33	25	16	7	1	---	---	---	189
December	18	---	---	---	2	10	17	23	25	24	19	12	4	0	---	---	---	136
1933																		
January	12	---	---	---	2	9	18	24	31	31	21	15	7	[illegible]	---	---	---	159
February	24	---	---	0	6	13	20	24	28	26	21	17	10	5	---	---	---	170
March	24	---	---	6	8	14	20	27	31	30	27	22	15	7	3	1	---	211
April	13	---	0	6	18	21	43	54	57	58	50	42	31	24	10	3	0	427
May	22	1	6	15	27	37	52	58	64	65	60	47	37	26	16	7	1	519
June[1]	14	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	484
July	----	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	----
August	----	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	----
September	----	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	----
October	19	---	---	0	7	15	23	28	33	31	28	21	13	4	0	---	---	203
November	24	---	---	0	7	15	24	27	27	24	19	12	5	1	0	---	---	161
December	25	---	---	---	1	8	14	17	18	16	13	8	3	0	---	---	---	98

[1] Time marks missing on a number of days, hence hourly values not determinable.

TABLE 1.—*Monthly, hourly and daily means of total radiation on Mount Washington, N. H. in gr cal/cm²*—Continued

Month	Number of days	Mean hourly totals during hour preceding: 5h	6h	7h	8h	9h	10	11	12	1h	2h	3h	4h	5h	6h	7h	8h	Mean daily total
1934																		
January	28	---	---	---	2	11	18	23	25	24	21	14	7	2	0	---	---	147
February	23	---	---	0	7	19	31	39	44	42	40	28	16	6	1	---	---	273
March[2]	27	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	[2] (295)
April	28	---	2	11	24	27	48	54	57	54	52	44	32	21	10	2	0	438
May	27	0	6	18	33	45	54	62	66	65	60	51	39	28	14	6	1	548
June	28	1	7	16	29	48	51	52	56	56	55	45	33	23	15	6	1	494
July[3]	----	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	----
August	11	0	4	16	32	48	57	65	57	52	48	40	32	18	9	2	---	480
September	26	---	1	6	17	28	38	42	45	43	40	30	22	14	7	1	---	334
October	30	---	---	2	9	19	27	32	34	33	29	22	14	6	1	---	---	228
November	26	---	---	0	2	10	18	18	20	21	15	11	6	1	---	---	---	122
December	29	---	---	---	1	6	13	16	18	18	15	10	4	1	---	---	---	102
1935																		
January	27	---	---	---	1	6	10	13	15	14	13	10	6	1	---	---	---	89
February	25	---	---	0	5	13	20	25	29	26	22	18	10	4	0	---	---	172
March	20	---	0	2	8	16	22	27	28	25	19	14	11	4	1	0	---	177
April[4]	(26)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	341
May[4]	(22)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	354
June	(15)	0	7	14	13	30	36	43	50	43	42	41	33	26	17	7	1	403
July[4]	(19)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	403
August	25	---	4	14	25	36	44	46	49	50	43	35	28	20	13	5	1	413
September[4]	----	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	----
October	20	---	---	1	6	13	23	26	32	36	30	24	17	7	1	---	---	216
November	17	---	---	0	3	10	19	26	29	29	24	16	10	2	---	---	---	168

[2] This value probably should be disregarded. On Mar. 8, 1934, it was found that the glass stem inside the bulb of the pyrheliometer was broken and the broken element slanting 64° from the vertical facing a direction 70° E. of N. A new instrument was not installed until Mar. 30; the method employed for obtaining the daily totals is crude and the results liable to grave errors.

[3] Pyrheliometer struck by lightning July 1; replaced Aug. 19.

[4] Pyrheliometer and recorder burned out by lightning at end of March 1935; 10-junction pyrheliometer installed, and eye readings obtained with Eppley potentiometer bridge until new recorder was installed. Recorder again failed, probably because of atmospheric phenomena (cf. A. A. McKenzie, Some Static Electric Phenomena, Mount Washington Observatory, Bull. Amer. Met'l. Soc., March 1935, pp. 78–80), in July and in September 1935. During the periods when only eye readings were available, linear variation of intensity between observations was assumed; hence hourly values were not calculated, and when the interval between 2 readings was 3 hours or more, the whole day was omitted.

[5] The number given is a mean value obtained by averaging the total month by number of hours, since on some days a whole day's record was not obtained.

TABLE 2.—*Monthly means of daily totals in 1933 at Blue Hill and Mount Washington in gr cal/cm²*

	January	February	March	April	May	June	July	August	September	October	November	December
Blue Hill	154	236	318	355	511	526	479	408	333	278	206	121
Mount Washington	159	170	210	427	519	484	----	----	----	203	161	98
Blue Hill—Mount Washington	−5	+66	+108	−72	−8	+42	----	----	----	+75	+45	+23

TABLE 3.—*Total radiation at Mount Washington during forenoon and afternoon in percent of the daily total; and comparison with Blue Hill*

	January	February	March	April	May	June	July	August	September	October	November	December
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1932												
A. m	----	----	----	----	----	----	----	----	----	----	57	57
P. m	----	----	----	----	----	----	----	----	----	----	43	43
1933												
A. m	53	53	50	49	50	----	----	----	----	52	62	59
P. m	47	47	50	51	50	----	----	----	----	48	38	41
1934												
A. m	54	51	----	51	52	53	----	58	53	54	56	53
P. m	46	49	----	49	48	47	----	42	47	46	44	47
1935												
A. m	51	54	58	----	----	49	----	53	----	47	52	----
P. m	49	46	42	----	----	51	----	47	----	53	48	----
1932–35												
A. m	53	53	54	50	51	51	----	55	53	51	57	56
P. m	47	47	46	50	49	49	----	45	47	49	43	44
BLUE HILL												
1933												
A. m	49	48	53	49	50	48	48	49	51	59	60	56
P. m	51	52	47	51	50	52	52	51	49	41	40	44

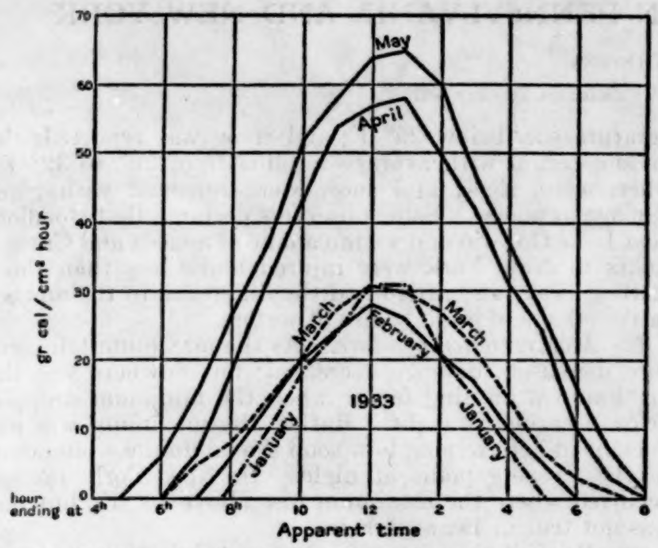

FIGURE 2. Monthly means of hourly sums of total radiation on a horizontal surface at Mount Washington, January–May, 1933.

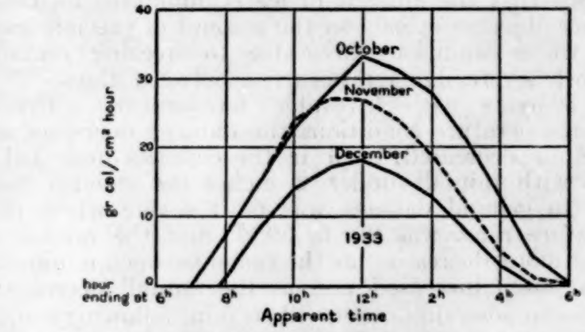

FIGURE 3. Monthly means of hourly sums of total radiation on a horizontal surface at Mount Washington, October–December, 1933.

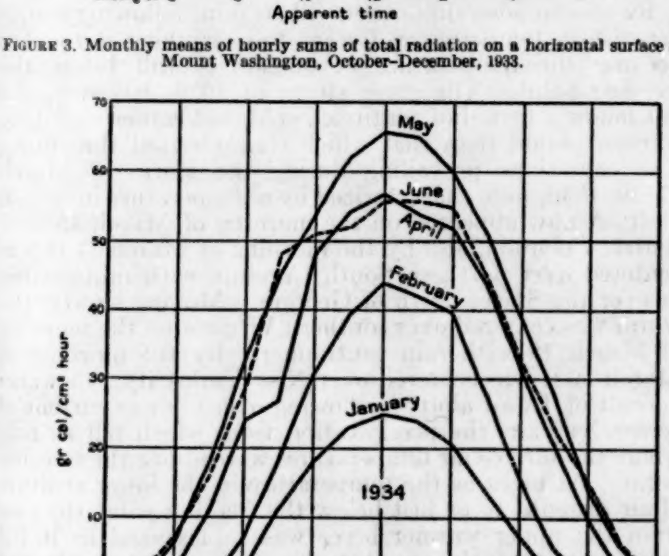

FIGURE 4.—Monthly means of hourly sums of total radiation on a horizontal surface at Mount Washington, January–February, April–June, 1934.

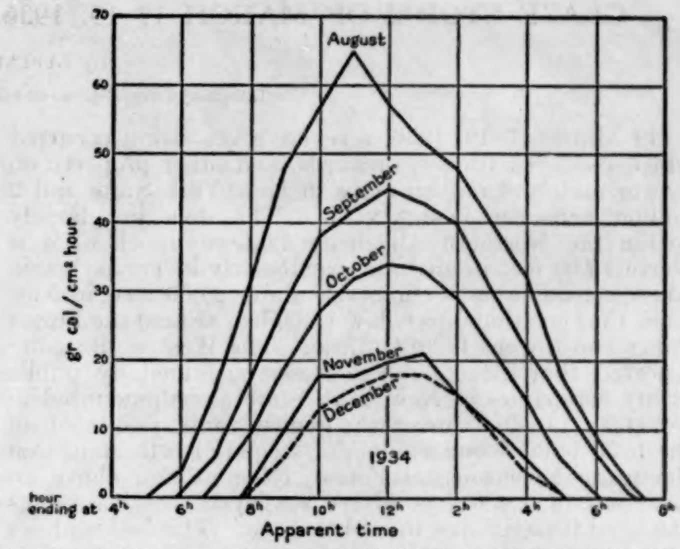

FIGURE 5. Monthly means of hourly sums of total radiation on a horizontal surface at Mount Washington, August–December, 1934.

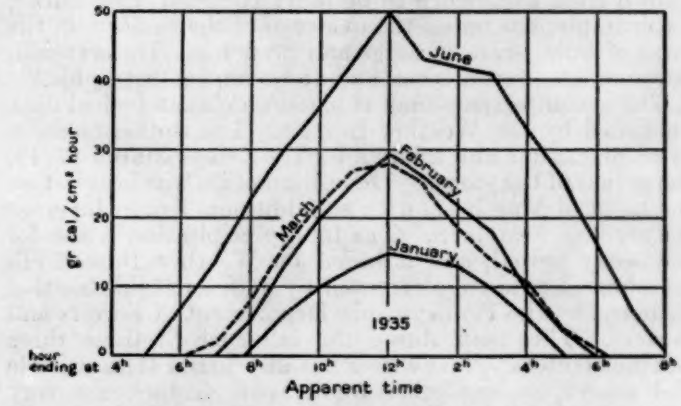

FIGURE 6. Monthly means of hourly sums of total radiation on a horizontal surface at Mount Washington, January–March, June, 1935.

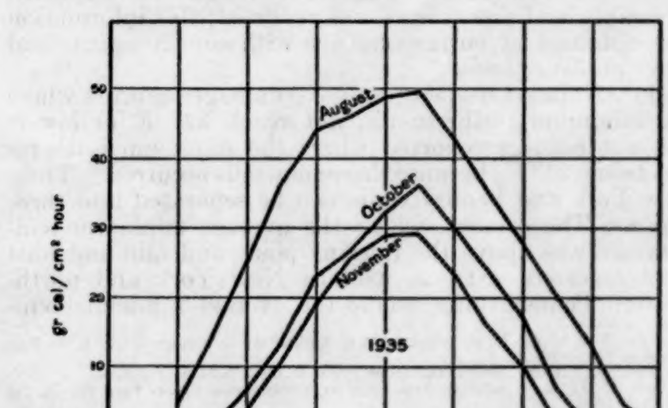

FIGURE 7. Monthly means of hourly sums of total radiation on a horizontal surface at Mount Washington, August, October, November, 1935.

GLAZE STORM OF MARCH 17-19, 1936, IN PENNSYLVANIA AND NEW YORK

By ALBERT A. DOWNS

[Allegheny Forest Experiment Station [1], Philadelphia, February 1937]

On March 17-19, 1936, a severe glaze storm occurred which damaged timber, orchards, and other property on approximately 4 million acres in New York State and 2 million acres in Pennsylvania. The area lies largely within the Northern Allegheny Plateau; much of it is above 1,500 feet in altitude, particularly in Pennsylvania where considerable portions rise above 2,000 feet; in New York the elevation dips below 1,000 feet around the Finger Lakes and toward Lake Ontario. The Weather Bureau [2] reported that glaze damage losses sustained by public utility companies in New York State alone amounted to $800,000. In northwestern Pennsylvania one-third of the total cubic wood volume of second-growth stands on the Kane Experimental Forest, lying at and above an elevation of 1,900 feet above sea-level, was classed as damaged material due to ice breakage. This loss is about 9 cords per acre.

Slight glaze storms which do not do much damage are known from experience to be fairly common; and Lutz [3], for example, has noted the evidence of their effects in the form of small scars on twigs and branches. On occasion, however, glaze storms can and do become catastrophic.[4]

The accompanying map is based on climatological data published by the Weather Bureau. The isotherms show average maxima and minima for the 3 days March 17-19, the period of the storm. Deposition of ice was heaviest on the night of March 17, with an additional lighter layer on the night of March 18. The total precipitation is also for the 3-day period, and is based on Weather Bureau climatological data supplemented by additional information gathered by the Pennsylvania Department of Forests and Waters. This map shows the influence of these three weather factors. The writer has also found that altitude and aspect, among other topographic factors, are very important locally. The cross-hatched area indicates the region in which glaze damage to trees, and to telephone, telegraph, and power lines was reported; this information was obtained by correspondence with county agents and other public agencies.

(1) *Minimum temperature.*—No damage occurred where the minimum isotherm did not reach 32° F. or lower; nor was damage reported where the minimum isotherm was below 29° F., because there snowfalls occurred. Thus, New York and Pennsylvania can be separated into three regions: The eastern, where the average minimum temperature was above the freezing point and rain and mist were reported; extreme western New York and northwestern Pennsylvania, where the average minimum temperature was below 29° F. and snow was reported; the middle region with average minima from 29° to 32° F., where rain, sleet, and snow were reported with glaze damage in places. Some observers declared that woodlots near Lake Ontario and within a mile of Seneca and Cayuga Lakes in New York were injured much less than those farther away, and attributed the difference to the ameliorative effects of large bodies of waters.

(2) *Maximum temperature.*—As the maximum temperature increased, damage decreased; but nowhere was the maximum a limiting factor when the minimum dropped below freezing at night. Rather the maximum was important in determining how soon the minimum would drop to the freezing point at night. In New York damage occurred where the maximum rose above 40° F., but this was not true in Pennsylvania.

(3) *Precipitation.*—Amount of precipitation was an important factor in the severity of the glaze damage. It is obvious that the amount of ice accumulated on trees and other objects depends on the amount of precipitation falling while conditions favorable to freezing prevail. The most severe damage occurred between the 3- and 4-inch isohyets with favorable temperatures. Under similar temperature conditions the damage decreased as the rainfall decreased, until in the counties near Lake Ontario with rainfall under 2 inches the damage was slight. In general damage was most severe where the temperature range was 29° to 39° F. and the rainfall 3 inches or more, decreasing as the range between minimum and maximum increased and as the rainfall decreased.

Ice storms sometimes occur when rain, following a sudden rise in temperature, freezes to everything it touches because the temperature of objects is still below the freezing point. The glaze storm of 1936, however, did not follow a period of continued cold, but rather a slightly warmer period than that which characterized the storm. The conditions prevailing during the storm of March 17-19, 1936, were characterized by a temperature inversion aloft: A LOW appeared on the morning of March 15 over central Colorado, and by the morning of March 17 it was centered over northern South Carolina with rain setting in over the States north of Georgia. Moving slowly, the storm was centered over southern Virginia on the morning of March 18 with rain continuing. By the morning of March 19 it was centered over New York City. A warm current of TA air aloft was flowing over a lower current of cooler NPP air, the precipitation from which fell as rain where the surface air temperatures were above the freezing point. At night as the temperature in the lower stratum of air dropped to or just below the freezing point the rain from the upper warmer layer was supercooled as it fell and froze instantly on obstacles such as telegraph and telephone wires, twigs, and branches which follow air temperatures closely.

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[1] Maintained by the U. S. Department of Agriculture in cooperation with the University of Pennsylvania.

[2] Climatological data, New York Section. Vol. 48, no. 3, p. 24, March 1936.

[3] Lutz, H. J. Scars resulting from glaze on woody stems. Jour. For., vol. 34, pp. 1039-1041, 1936.

[4] See, for example, Monthly Weather Review, December 1900, vol. 28, p. 548; January 1920, vol. 48, p. 50; February 1922, vol. 50, pp. 77-82. Abell, Chas. A. Influence of glaze storms upon hardwood forests in the southern Appalachians. Jour. For., vol. 32, pp. 35-37.

FIGURE 1.—Breakage, uprooting, and bending of trees caused by weight of ice during severe glaze storm of March 17–19, 1936, on the Kane Experimental Forest, Elk County, Pa.

UNIV. OF MICH.

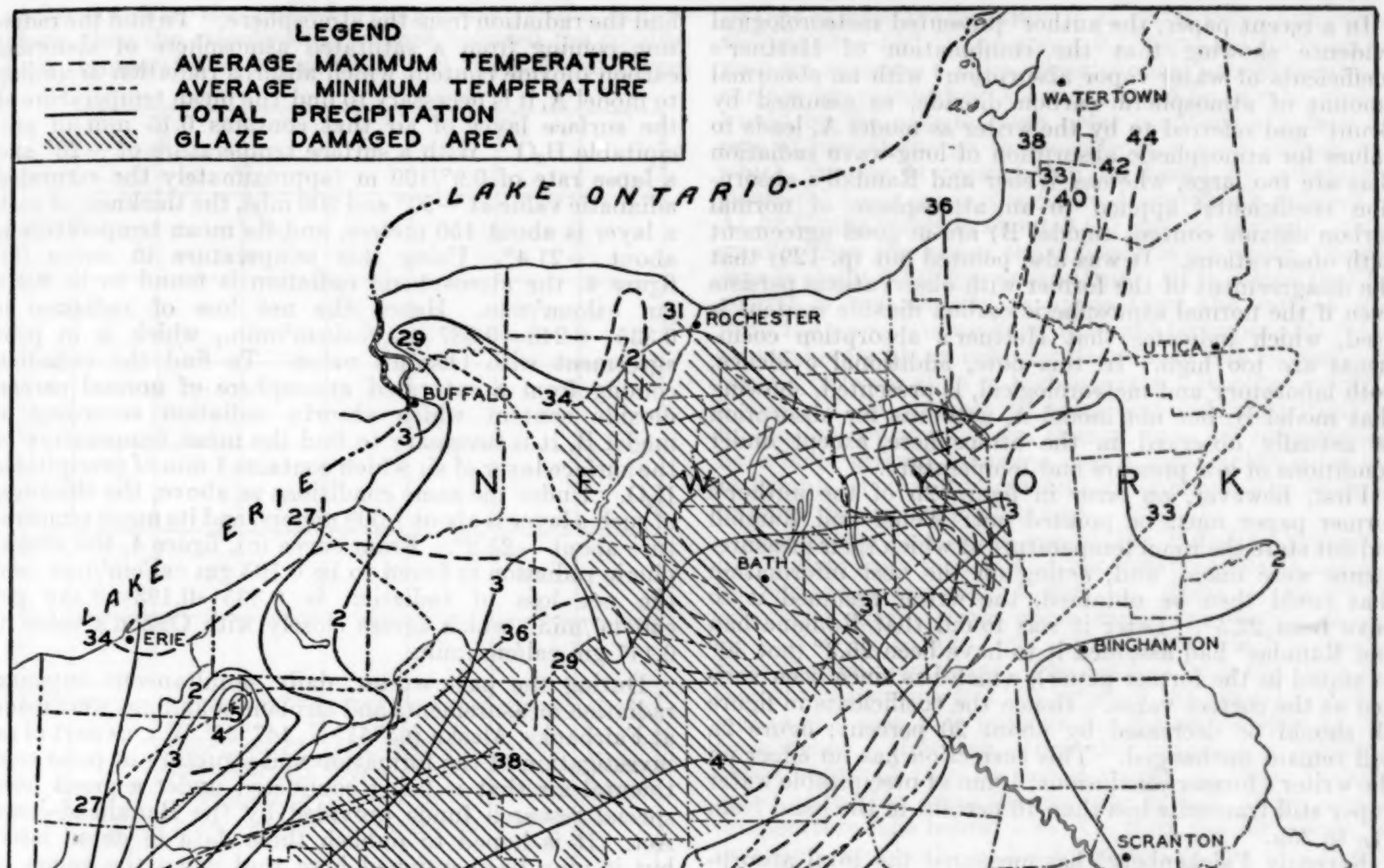
LEGEND
AVERAGE MAXIMUM TEMPERATURE
AVERAGE MINIMUM TEMPERATURE
TOTAL PRECIPITATION
GLAZE DAMAGED AREA
LAKE ONTARIO
LAKE ERIE
NEW YORK
PENNSYLVANIA
WATERTOWN
ROCHESTER
UTICA
BUFFALO
BATH
BINGHAMTON
ERIE
SCRANTON
PITTSBURGH
ALTOONA
HARRISBURG
PHILADELPHIA

FIGURE 2.

ABSORPTION OF RADIATION BY WATER VAPOR AS DETERMINED BY HETTNER AND BY WEBER AND RANDALL

By H. WEXLER

[Weather Bureau, Washington, D. C., March 1937]

In a recent paper, the author[1] presented meteorological evidence showing that the combination of Hettner's coefficients of water vapor absorption[2] with an abnormal amount of atmospheric carbon dioxide, as assumed by Brunt[3] and referred to by the writer as model A, leads to values for atmospheric absorption of long-wave radiation that are too large, whereas Weber and Randall's absorption coefficients[4] applied to an atmosphere of normal carbon dioxide content (model B) are in good agreement with observations. It was also pointed out (p. 129) that the disagreement of the former with observations persists even if the normal atmospheric carbon dioxide content is used, which indicates that Hettner's absorption coefficients are too high. In this note, additional evidence, both laboratory and meteorological, is presented, showing that model B, but not model A, accounts for absorption as actually observed in the atmosphere, except under conditions of low pressure and temperature.

First, however, an error in figure 2b of the author's former paper must be pointed out: Weber and Randall did not state the room temperature at which their measurements were made; and, acting on the best information that could then be obtained, the writer assumed it to have been 22.5°. Later it was found that Ramanathan and Ramdas[5] had assumed it to have been 26.3° (not 30° as stated in the former paper), which has since been verified as the correct value. Hence the coefficients in figure 2b should be decreased by about 20 percent; figure 2a will remain unchanged. This correction has no effect on the writer's former conclusions; 1 mm of precipitable water vapor still transmits less than 10 percent in the band from 17μ to 25μ.

Recently Falckenberg[6] has measured the total absorption of long-wave radiation by water vapor; and his results show much less absorption than Hettner's coefficients would indicate, although his demonstration is not so convincing as it might be, because he had to make a sixfold extrapolation of one of his curves.

In a discussion of the Polar Year observations at Mount Nordenskiöld, Spitsbergen (1,049 meters), Olsson[7] found that the average net loss of radiation during clear weather in the winter half of the year was 0.147 gm cal/cm²/min. at a temperature of −20.7° C.[8] Practically all the observations were made at a temperature of about −20°; the station was generally above the ground inversion and in a region of strong cyclonic activity, and hence probably almost continuously exposed to polar maritime air. The curves in figure 4 of the author's paper[1] provide a means of checking Olsson's result: Assuming the snow surface at Mount Nordenskiöld to radiate as a black body at a mean temperature of −20.7° C., it would radiate 0.335 gm cal/cm²/min. From the curves in figure 4 it is possible to find the radiation from the atmosphere. To find the radiation coming from a saturated atmosphere of abnormal carbon dioxide content which absorbs radiation according to model A, it is necessary to find the mean temperature of the surface layer of air that contains 0.15 mm of precipitable H_2O. With a surface temperature of −20° and a lapse rate of 0.9°/100 m (approximately the saturated adiabatic value at −20° and 900 mb), the thickness of such a layer is about 150 meters, and its mean temperature is about −21.4°. Using this temperature in curve (*b*), figure 4, the atmospheric radiation is found to be 0.248 gm cal/cm²/min. Hence the net loss of radiation is $0.335-0.248=0.087$ gm cal/cm²/min., which is in poor agreement with Olsson's value. To find the radiation coming from a saturated atmosphere of normal carbon dioxide content which absorbs radiation according to model B, it is necessary to find the mean temperature of the surface layer of air which contains 1 mm of precipitable H_2O. Under the same conditions as above, the thickness of such a layer is about 1,000 meters, and its mean temperature about −25.2°. From curve (c), figure 4, the atmospheric radiation is found to be 0.193 gm cal/cm²/min. and the net loss of radiation is $0.335-0.193=0.142$ gm cal/cm²/min., which agrees closely with Olsson's value of 0.147 gm cal/cm²/min.

During the past winter, daily simultaneous outgoing radiation measurements and airplane soundings were made at Fairbanks, Alaska (65°51′ N, 147°52′ W.), as part of an investigation of the formation and structure of polar continental air that is being conducted under a grant from special research funds provided by the Bankhead-Jones Act. It is hoped to publish these data in detail later; but it may be mentioned here that when the values of radiation coming from the cloudless atmosphere were plotted against temperature of the isothermal layer (as determined by the airplane sounding) all but a few of the 48 points fell between curves (*b*) and (*c*) in figure 4 of the previous paper. At temperatures near 0° C., most of the points were closer to curve (*b*) (determined from model A); at intermediate temperatures they were located about midway between the two curves; and at temperatures from about −20° C. to about −30° C., they were grouped about curve (*c*) (determined from model B). The radiation observations were made with the Abbot-Aldrich Melikeron; and some of the values of atmospheric radiation derived from them are undoubtedly too large, since 2/10 clouds and also local smoke and light fog were included in the clear sky category.

The writer has presented three separate examples in which model B gave the better agreement with meteorological observations[1]. The first of these is the magnitude of ground inversions; and a particularly striking instance, shown in the accompanying figure, was observed in a recent airplane sounding at Fairbanks, Alaska, made during nearly calm, cloudless, and sunless conditions. The temperature at the snow surface was −44.3° C., and it increased nearly 20° in the first 35 meters, a layer occupied by a dense ground fog. From 540 meters to about 1,900 meters the temperature was very nearly constant at −15° C., and thereafter decreased in a normal manner to −35° at 5 km. From the temperature of the

[1] H. Wexler, Cooling in the Lower Atmosphere and the Structure of Polar Continental Air, MONTHLY WEATHER REVIEW, 64, 122, April 1936.

[2] G. Hettner, Über das ultrarote Absorptionsspektrum des Wasserdampfes, Ann. d. Phys., 55, 476, 1918.

[3] D. Brunt, Phys. and Dyn. Meteorology, Cambridge, 1934.

[4] L. R. Weber and H. M. Randall, Absorption Spectrum of Water Vapor beyond 10μ, Phys. Rev., 40, 835, 1932.

[5] K. R. Ramanathan and L. A. Ramdas, Derivation of Ångströms' Formula for Atmospheric Radiation, etc. Proc. Ind. Acad. Sci. 1, 822. 1935.

[6] G. Falckenberg, Experimentelle zur Absorption dünner Luftschichten für infrarote Strahlung, Meteorol. Z, 53, 172, May 1936.

[7] H. Olsson, Sunshine and Radiation, Mount Nordenskiöld, Spitsbergen, Geog. Ann., heft 1, p. 93, 1936.

[8] The mean deviation, as found by the author from Olsson's observations is ±0.009 gm cal/cm²/min.

isothermal layer, −15° C., it is possible with the aid of the curves in figure 4 of the previous paper to determine the equilibrium surface temperature. With model A, this temperature is found to be −33.8° C., much higher than that observed; while with model B, it is −45.2° C., only 0.9° lower than that observed. If the latter correctly portrays the radiation properties of the atmosphere, then the calculated difference between the equilibrium temperatures of surface and isothermal layers

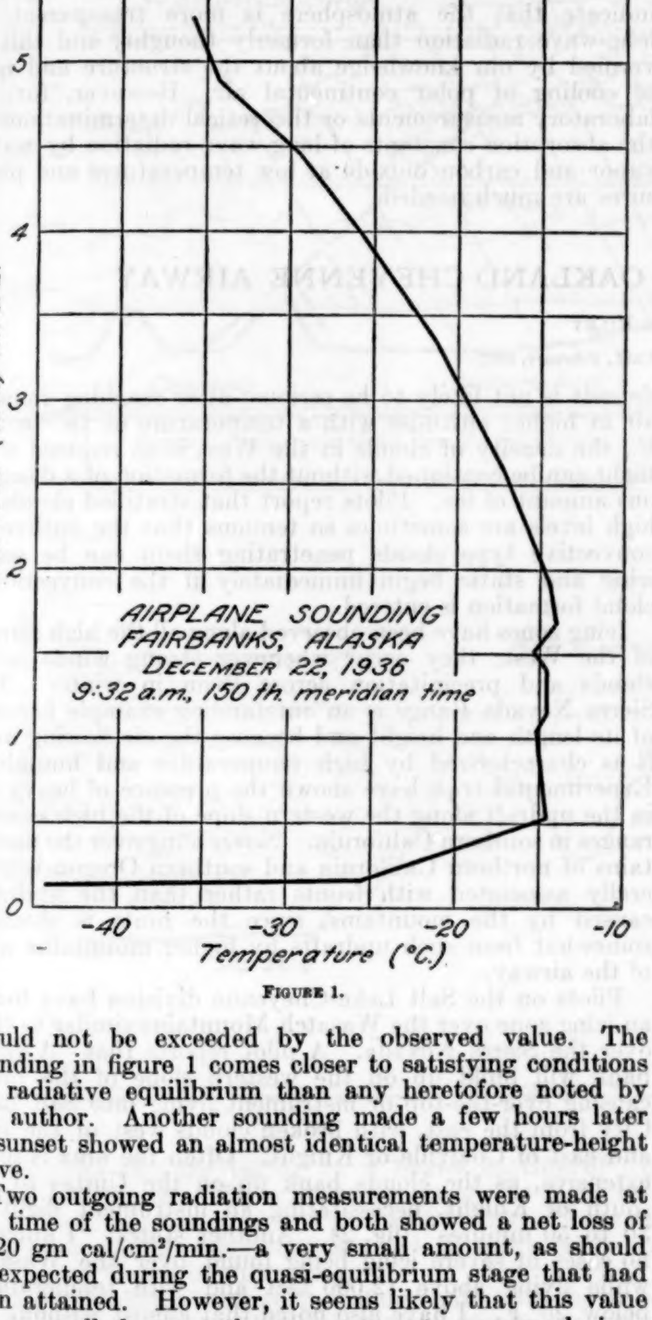

FIGURE 1.

should not be exceeded by the observed value. The sounding in figure 1 comes closer to satisfying conditions for radiative equilibrium than any heretofore noted by the author. Another sounding made a few hours later at sunset showed an almost identical temperature-height curve.

Two outgoing radiation measurements were made at the time of the soundings and both showed a net loss of 0.020 gm cal/cm²/min.—a very small amount, as should be expected during the quasi-equilibrium stage that had been attained. However, it seems likely that this value is too small, because the measurements were made in a dense fog and had to be abandoned shortly thereafter on account of frosting of the instrument. According to the curves mentioned above, the net loss of energy at the quasi-equilibrium stage should have been 0.080 gm cal/cm²/min.

The atmosphere not only loses energy to space by way of the snow surface, but also directly to space by means of the Albrecht emission layer,[9] a layer about 3 km thick situated in the upper atmosphere below the −50° C. isotherm. Albrecht found from Hettner's absorption data that the rate of loss of energy would be nearly equal to that of selective radiation from water vapor and carbon dioxide at −50° C., or about 0.170 gm cal/cm²/min. If now we examine a calm, clear, sunless atmosphere, with surface temperature 0° C. and a steep lapse rate, such as would be the case in fresh polar maritime air, then the rate of loss of energy to space from a snow surface over which the air is passing can be found by subtracting curve (b) from (a) in the figure 4 previously referred to. At 0° C. the result is about 0.127 gm cal/cm²/min., much smaller than the loss at the emission layer which Albrecht says is about 0.170 gm cal/cm²/min. If it is true that less energy is lost directly to space from the surface than from the upper atmosphere, it would be impossible for an atmosphere with an initially steep lapse rate to cool more rapidly in lower than in higher levels. In other words, it would not be possible to transform polar maritime air into polar continental air, that is, into air characterized by a large ground inversion and a very stable lapse rate to heights of 2 or 3 kilometers, as is commonly observed in polar regions during winter.

If, however, we make use of the radiative properties that follow from model B, it becomes possible to account for surface inversions. Curve (c), figure 4, shows the selective radiation from water vapor and carbon dioxide at −50° C. to be 0.135 gm cal/cm²/min., which is the loss from the emission layer. The net loss from the snow surface at temperature 0° C. is larger, 0.186 gm cal/cm²/min., and in this case it is possible for the atmosphere to cool from below. However, when the surface has cooled to about −20° C. then its loss of energy to space becomes equal to the loss from the emission layer. If the surface temperature falls below −33° C., then the air above the inversion can also be cooled by radiation, but at a smaller rate than aloft at the emission layer; and as cooling continued, a steep lapse rate would be maintained above a surface inversion, a conclusion which is not in agreement with observations of the structure of polar continental air, which even at very low surface temperatures has a stable lapse rate to some height above the surface inversion. Hence, even on the basis of Weber and Randall's data, the value of the loss from the emission layer is much too high, probably because the effect of low pressure and temperature on the water vapor absorption spectrum is to diminish the continuous character of the spectrum by decreasing the width of the absorption lines and increasing their intensity, as pointed out by Albrecht.[10] That is, the transparent portions of the spectrum increase at the expense of the opaque portions; and at low pressure and temperature, the atmosphere becomes more transparent to radiation. Apparently, the emission layer may no longer be considered as composed only of 2 or 3 kilometers of air below the −50° C. isotherm, but in reality consists of the major portion of the troposphere below this isotherm, with the region of maximum loss of radiation probably situated near the central portion of the layer.

The width of an absorption line is proportional to barometric pressure and to the square root of absolute temperature[10]; hence, at sea-level pressure the effect of low tempera-

[9] F. Albrecht, Der Wärmeumsatz durch die Wärmestrahlung des Wasserdampfes in der Atmosphäre. Zeitsch. f. Geophy., 6, 420, 1930. Über die "Glashauswirkung" der Erdatmosphäre und das Zustandekommen der Troposphäre. Meteorol. Z., 48, 57, 1931.

[10] F. Albrecht, Das Quantentheoretisch gegebene Wasserdampfspektrum über den Wärmeumsatz strahlender Luftschichten, Meteorol. Z, 48, 476, 1931.

ture on the absorption spectrum will not be so great as at the lower pressure of the emission layer. We may assume curve (c) of figure 4 to represent with sufficient accuracy the radiation coming to the surface from a cold atmosphere, but not the radiation leaving the atmosphere at high levels. From observations of polar continental air at low temperatures, it becomes possible to place an upper limit on the amount of radiation that leaves the atmosphere by way of the emission layer. A surface temperature of −60° C., which has commonly been observed in Alaska and Siberia, corresponds to an equilibrium temperature of −34° C. for the isothermal layer above it.[11] From the difference between curves (a) and (c) of figure 4, the net loss of radiation to space from the surface is found to be 0.054 gm cal/cm^2/min. The loss to space from the emission layer must not exceed this amount, for otherwise the atmosphere could not cool and at the same time preserve a stable lapse rate in lower levels. An even lower limit can be placed on the radiation if we notice that the isothermal layer in sounding (a), figure 1, of the writer's previous paper, has a temperature of −41° C., corresponding to an equilibrium surface temperature of −66° C. In this case the net loss of radiation from the surface is 0.044 gm cal/cm^2/min., which is an upper limit to the loss of radiation from the emission layer.

In conclusion, it therefore appears that model B is more satisfactory for computations which involve atmospheric radiation than is model A. Furthermore, the measurements of Weber and Randall, and the effects of low temperature and pressure on absorption, together indicate that the atmosphere is more transparent to long-wave radiation than formerly thought; and this is verified by our knowledge about the structure and rate of cooling of polar continental air. However, further laboratory measurements or theoretical determinations of the absorption constants of long wave radiation by water vapor and carbon dioxide at low temperatures and pressures are much needed.

AIRCRAFT ICING ZONES ON THE OAKLAND-CHEYENNE AIRWAY

By JOHN A. RILEY

[Weather Bureau, Oakland Calif., February, 1937]

The formation of ice on aircraft is one of the greatest hazards to air traffic today, with the accompanying complications of turbulence which makes the airplane difficult to control and of static which interferes with the operation of vocal and directional radio facilities. The meteorological aspect of the problem has been somewhat simplified in recent years by the recognition that most icing, (as well as other unfavorable conditions, such as precipitation, low ceiling, and poor visibility) occurs in restricted areas: First, along the moving fronts that separate different air masses; and second along high mountain ranges. The worst conditions in the far West occur when the two coincide, that is, while a front is passing over a mountain range.

The icing zones along mountain ranges will be considered first. During the winter, strong westerly winds blowing across mountain ranges cause severe turbulence along the crest of the mountains where the air flow is greatly accelerated. Along the Oakland to Cheyenne route there are four ranges over 8,000 feet high: Sierra Nevada, Ruby, Wasatch, and Rocky Mountains. During cloudy, rainy weather over the coastal region and Pacific slope, snows in the intermountain region, and westerly gales with near freezing temperatures along the mountain crests, a zone of severe icing occurs in the region of turbulence along the top of these high ranges.

Before it was known that severe icing is to be expected in the turbulent region along a mountain crest, the pilot would frequently push into it and, upon starting to take on ice, would turn back and climb higher, repeating the process if necessary until he was above it or returning to the point of departure. Due to a better understanding of the condition, such procedure is no longer necessary; instead the pilot climbs above the icing zone before reaching the mountains, generally 12,000 feet or slightly higher, and maintains this altitude until safely beyond the icing zone on the other side. (See figure 1.)

While he is climbing through clouds, and possibly through light precipitation over the valleys, a slight amount of ice forms as the airplane climbs through a stratum having temperatures ranging from freezing to 25° F. or lower, but in the absence of turbulence the deposit is not likely to be serious; after reaching smooth air at higher altitudes with a temperature of 18° to 20° F., the density of clouds in the West is so reduced that flight can be continued without the formation of a dangerous amount of ice. Pilots report that stratified clouds at high levels are sometimes so tenuous that the outline of convective type clouds penetrating them can be seen; icing and static begin immediately if the convectional cloud formation is entered.

Icing zones have been observed along all the high ranges of the West; they occur whenever strong winds carry clouds and precipitation across them in winter. The Sierra Nevada Range is an outstanding example because of its length and height and because the air flowing over it is characterized by high temperature and humidity. Experimental trips have shown the presence of heavy ice in the updraft along the western slope of the high coastal ranges in southern California. *Severe* icing over the mountains of northern California and southern Oregon is generally associated with fronts rather than the updrafts caused by the mountains, since the route is shielded somewhat from such updrafts by higher mountains west of the airway.

Pilots on the Salt Lake-Cheyenne division have found an icing zone over the Wasatch Mountains similar to that over the Sierra Nevada. A pilot reports that "A cloud bank will build up on the western slope of the range causing over-the-top or instrument flying into Salt Lake City from the east, with broken clouds west of the lake and east of Coalville or Knight. Often the area is more extensive, as the clouds bank up on the Uintas to the south of Knight, necessitating an instrument flight of 30 to 50 minutes" (fig. 2). Another states: "I know of no cases of severe icing being found over the Wasatch while flying above 12,000 feet and with temperatures below 20° F. I have also noted that almost without exception the amount of icing and the turbulence increases several fold during the few minutes we are directly above the highest peaks."

Another pilot, however, has reported rapid accumulation of ice while flying in a cloud at 14,000 feet over the Wasatch Mountains with temperature between zero and

[11] H. Wexler, Cooling in the Lower Atmosphere and the Structure of Polar Continental Air, Monthly Weather Review, 64, 122, April 1936.

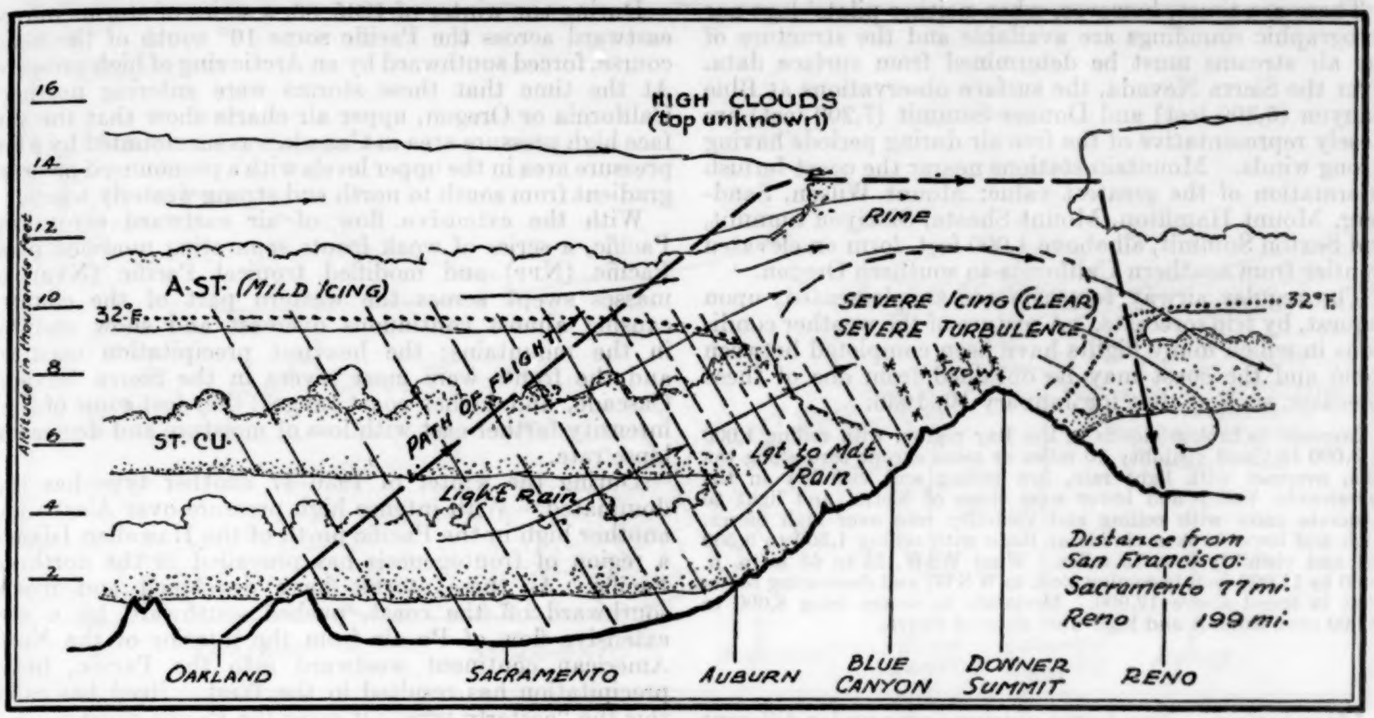

FIGURE 1.—Vertical cross section along the San Francisco airway, showing region of severe icing and the flight path to avoid icing.

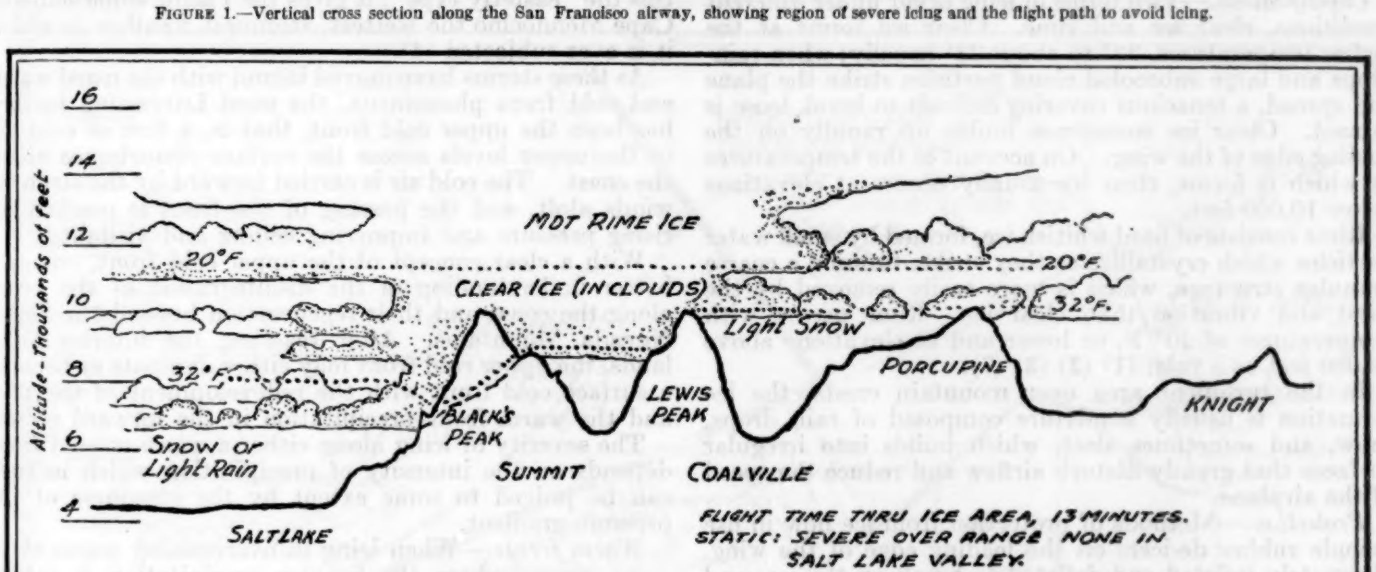

FIGURE 2.

10° F., the airplane taking on a heavy coating of ice within 10 minutes. The circumstances of this flight are not known, but the icing was probably within a front; a somewhat similar experience is cited in the section on icing along fronts in this paper.

From Pendleton comes the statement: "We have a condition here in the Northwest that closely parallels that over the Sierras. To the east are the Blue Mountains and to the west the Cascade Range. Icing is quite prevalent for planes passing through either area, especially over the Blue Mountains because the temperatures are generally lower and it is often necessary to climb to 18,000 to 20,000 to get on top of all cloud formations."

FORECASTS

The surface weather map, wind-aloft charts, and aerographic flights all contribute data of fundamental importance in the preparation of airway forecasts. Pilots keep a log of all trips, based on observations at 30-minute intervals; along the west slope of the Sierra Nevada temperature readings are made for every thousand feet. Along an airway where several trips are made daily, a good cross section is obtainable. Frequent temperature readings show that when icing conditions exist, the saturation adiabatic lapse rate prevails from near the surface to 13,000 feet.

There are times, however, when neither pilots' logs nor aerographic soundings are available and the structure of the air streams must be determined from surface data. Over the Sierra Nevada, the surface observations at Blue Canyon (5,300 feet) and Donner Summit (7,200 feet) are closely representative of the free air during periods having strong winds. Mountain stations nearer the coast furnish information of the greatest value: Mount Wilson, Sandberg, Mount Hamilton, Mount Shasta, Siskiyou Summit, and Sexton Summit, all above 4,000 feet, form an elevated frontier from southern California to southern Oregon.

The regular airway forecasts are supplemented, upon request, by trip forecasts. A picture of the weather conditions in which many flights have been completed between Reno and the coast may be obtained from one of these forecasts, such as that for January 10, 1936:

Overcast to broken clouds in the Bay region, with ceiling 1,000 to 3,000 feet and visibility 10 miles or more except zero along the hills; overcast with light rain, low ceiling and visibility in the Sacramento Valley and lower west slope of Sierra, and light to moderate snow with ceiling and visibility zero over high Sierra. High and lower broken clouds at Reno with ceiling 1,500 to 3,500 feet and visibility 6 to 15 miles. Wind WSW. 55 to 65 m. p. h. 8,000 to 11,000 feet, becoming west to WNW. and decreasing somewhat in speed above 12,000. Moderate to severe icing 8,000 to 11,000 over summit and high west slope of Sierra.

ICE

Classification.—Two forms of icing occur under different conditions, clear ice and rime. Clear ice forms at the higher temperatures, 32° to about 23° usually; when raindrops and large subcooled cloud particles strike the plane and spread, a tenacious covering difficult to break loose is formed. Clear ice sometimes builds up rapidly on the leading edge of the wing. On account of the temperatures at which it forms, clear ice usually occurs at elevations below 10,000 feet.

Rime consists of hard whitish ice, formed by small water particles which crystallize as they strike, forming a coarse granular structure, which is more easily removed by the wind and vibration than clear ice. Rime occurs with temperatures of 20° F. or lower and at elevations above 10,000 feet as a rule: (1) (2) (3) (7).

In the turbulent area over mountain crests, the ice formation is usually a mixture composed of rain drops, snow, and sometimes sleet, which builds into irregular surfaces that greatly disturb airflow and reduce the speed of the airplane.

Protection.—Methods of protection from ice now in use include rubber de-icers on the leading edge of the wing, alternately inflated and deflated to break up the ice; and "slinger rings" which spread a film of alcohol and glycerine to the propellor blades that, if turned on before icing starts, causes the ice to slip from the propellors as it forms and thus prevents serious vibration.

The practice, initiated several years ago, of heating the carburetor intake almost eliminates a once common icing hazard.

ICING ALONG FRONTS

The predominating characteristics of the weather map have been different for each of the past three winters. During the winter of 1934–35, with low pressure areas moving southeastward from Canada into the interior of the United States, a procession of cold fronts extending NE–SW moved southeastward across the western highlands, losing little of their intensity and carrying moderate to heavy snow and very low ceilings eastward to the Rockies.

During the winter of 1935–36, a series of storms moved eastward across the Pacific some 10° south of the usual course, forced southward by an Arctic ring of high pressure. At the time that these storms were entering northern California or Oregon, upper air charts show that the surface high pressure area in Canada was surmounted by a low pressure area in the upper levels with a pronounced pressure gradient from south to north and strong westerly winds.

With the extensive flow of air eastward across the Pacific, a series of weak fronts separating modified polar Pacific (NPP) and modified tropical Pacific (NTP) air masses swept across the western part of the country causing almost continuous overcast and snow and fog in the mountains; the heaviest precipitation occurred and the fronts were most severe in the Sierra Nevada, Cascade, and higher coast ranges; they lost some of their intensity farther east with loss of moisture and decreasing lapse rate.

During the winter of 1936–37 another type has predominated. With intense high pressure over Alaska and another high in the Pacific north of the Hawaiian Islands, a region of frontogenesis has prevailed in the northeast Pacific. As these storms have developed and moved southward off the coast, pushed southward by a very extensive flow of Pc air from the interior of the North American continent westward into the Pacific, heavy precipitation has resulted in the West. Reed has called this the "easterly type"; it gives the Pacific slope south of Cape Mendocino the wettest, stormiest weather to which it is ever subjected (4).

As these storms have moved inland with the usual warm and cold front phenomena, the most interesting feature has been the upper cold front, that is, a flow of cold air in the upper levels across the surface disturbance along the coast. The cold air is carried forward by the stronger winds aloft, and the passing of the front is marked by rising pressure and improving ceiling and visibility.

With a clear concept of the upper cold front, comes a better understanding of the disintegration of the LOWS along the coast and their regeneration beyond the Sierra Nevada Mountains. After reaching the interior highlands, the upper cold front may either dissipate or become a surface cold front with the redevelopment of the LOW and the warm front precipitation in the forward sector.

The severity of icing along either a warm or cold front depends on the intensity of precipitation which in turn can be judged to some extent by the steepness of the pressure gradient.

Warm fronts.—When icing in overrunning warm air is more severe where the heavier precipitation is taking place along the warm front, this fact indicates that the frontal surface is steep and therefore that it can be passed through in a shorter time. In most cases, severe icing in the overrunning air along a warm front can usually be escaped by a change in altitude of 1,000 to 2,000 feet, provided the pilot keeps in mind the direction of slope of the frontal surface. Normally, the temperatures in the lower air are too high for ice formation.

Many flights are successfully completed by flying in the inversion above an icing condition but it is important to remember, that it is not always possible to find temperatures above freezing over a region of freezing mist, as Kaster has pointed out (5): "The experiences of commercial pilots have shown that after cloud particles become subcooled, further condensation can take place causing the subcooled particles to grow until they fall as mist or even light rain. Under these conditions freezing mist may be found from the ground up to the cloud base,

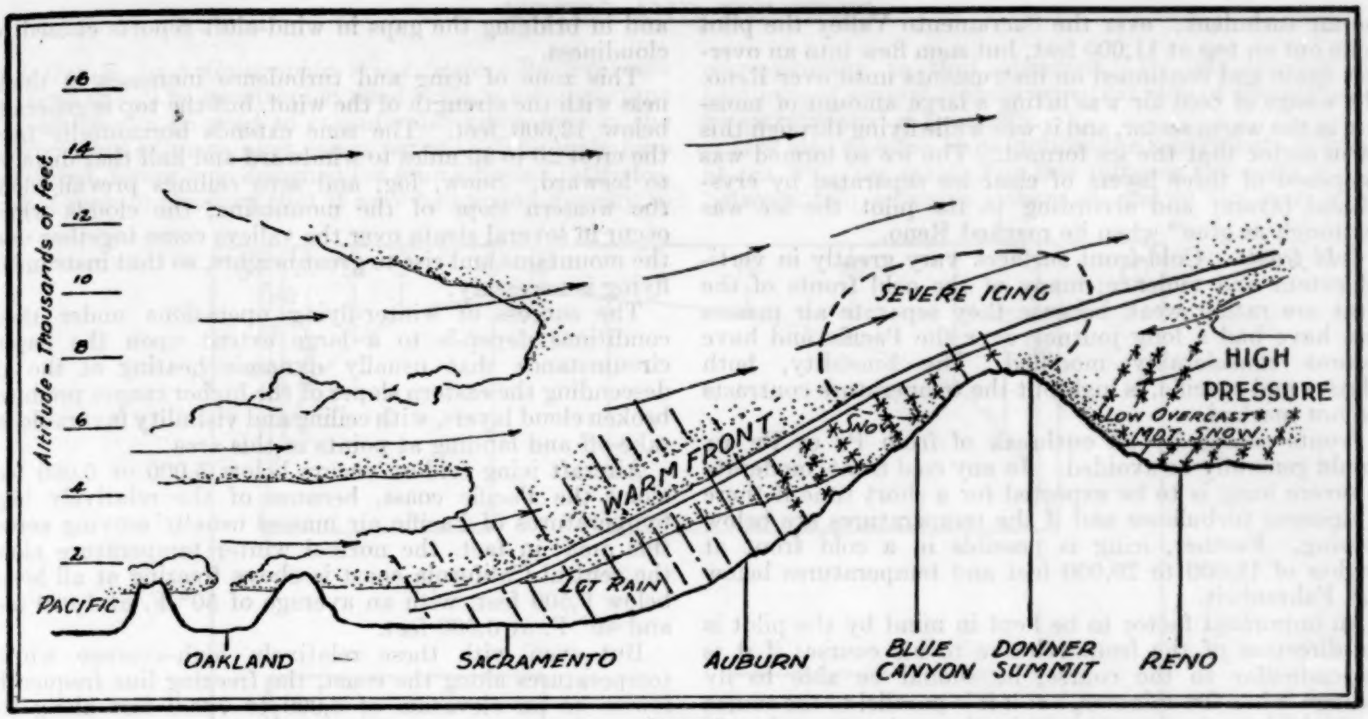

FIGURE 3.

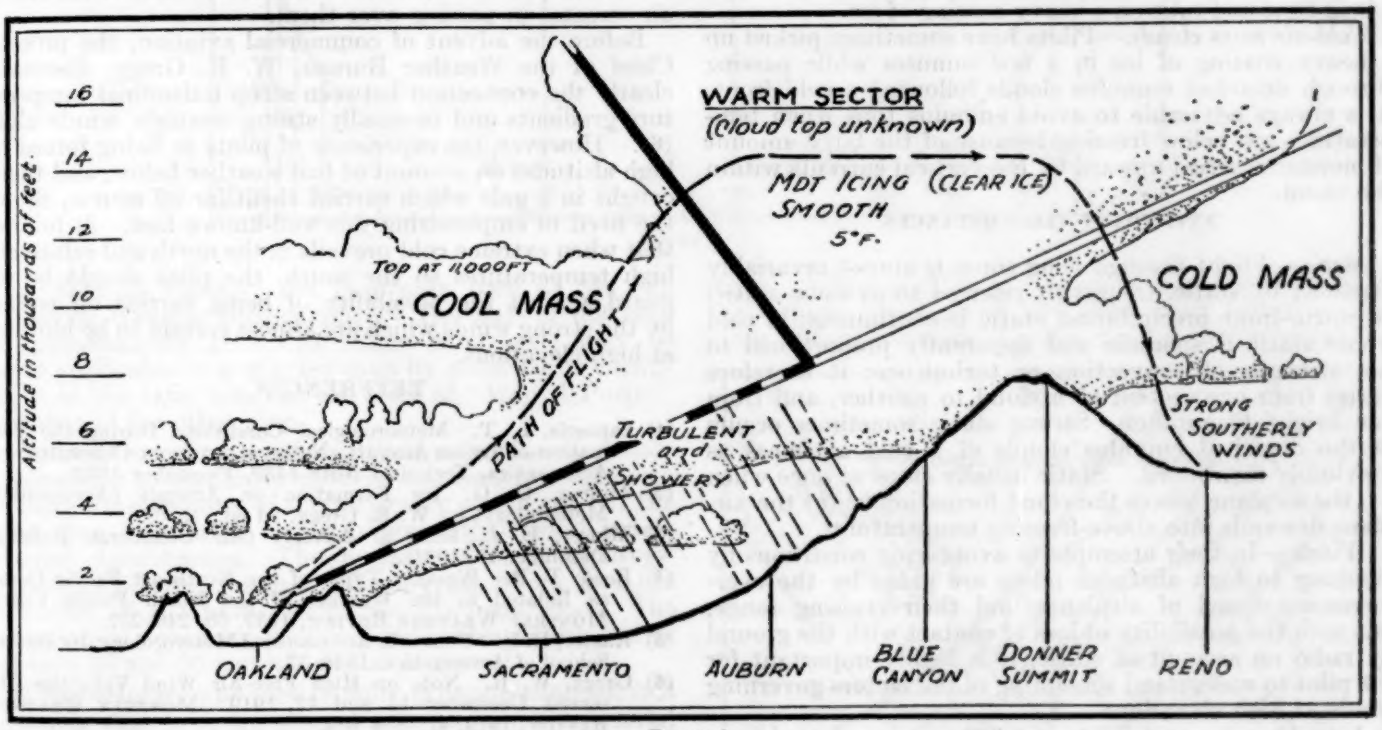

FIGURE 4.

and subcooled cloud particles from there to the top of the cloud." This condition has been frequently observed in the East.

Pilots on the midcontinent airway seldom encounter severe icing in warm fronts between San Francisco and Salt Lake City, except while the front is passing over the mountains. An exception to this is a warm front which approaches the mountains when high pressure is built up along the east side; in this case the high pressure is in effect a continuation of the upward slope of the mountains, and the warm front is continuous and active to great heights (fig. 3). But it is generally observed that the turbulent descent of the air along the eastern slope tends to break up the front to such an extent that conditions are not favorable for heavy icing (fig. 1). The surface of discontinuity again forms as the warm air overruns the next range, but always with decreased intensity after having passed higher ranges to the west.

On the night of January 27, 1937, an eastbound pilot took on ice rapidly for a few minutes over the Sierra Nevada summit in smooth air at 14,000 feet, where the temperature was 5° F., while a small lapse rate prevailed from the 10,000-foot level. Rapid icing under these conditions is unusual; examination shows that he had passed through the complicated frontal structure shown in figure 4. Near the coast the weather was showery and

the air turbulent; over the Sacramento Valley the pilot came out on top at 11,000 feet, but soon flew into an overcast again and continued on instruments until over Reno. The wedge of cold air was lifting a large amount of moisture in the warm sector, and it was while flying through this warm sector that the ice formed. The ice so formed was composed of three layers of clear ice separated by crystallized layers; and according to the pilot the ice was "as tough as glue" when he reached Reno.

Cold fronts.—Cold-front surfaces vary greatly in vertical extent and violence; many of the cold fronts of the West are rather weak because they separate air masses that have had a long journey over the Pacific and have become considerably modified. The humidity, both relative and specific, is high but the temperature contrasts are not marked.

Fronts caused by an outbreak of fresh Pc or Pp air should generally be avoided. In any cold front, moderate to severe icing is to be expected for a short time if there is vigorous turbulence and if the temperatures are below freezing. Further, icing is possible in a cold front at heights of 18,000 to 20,000 feet and temperatures below zero Fahrenheit.

An important factor to be kept in mind by the pilot is the direction of the front relative to his course; if it is perpendicular to the course, he should be able to fly through it in a few minutes, but if it is parallel to the course he might have to remain within the active frontal zone a long time and take on a heavy coating of ice.

Cold-air mass clouds.—Pilots have sometimes picked up a heavy coating of ice in a few minutes while passing through detached cumulus clouds following a cold front; it is always advisable to avoid cumulus tops when temperatures are below freezing because of the large amount of moisture carried upward by the vertical currents within the cloud.

ATTENDANT CIRCUMSTANCES

Static.—Flight through icing zones is almost invariably attended by static, frequently referred to as snow static. In warm-front precipitation static is continuous; in cold fronts static is sporadic and apparently proportional to the strength of convection or turbulence; it therefore varies from one section of a cloud to another, and from one height to another. Strong static sometimes occurs in the detached cumulus clouds of a cold air mass as previously mentioned. Static usually stops at once when (*a*) the airplane leaves the cloud formation or (*b*) the airplane descends into above-freezing temperatures.

Winds.—In their attempts to avoid icing conditions by climbing to high altitudes pilots are aided by the ever-increasing speed of airplanes and their cruising range, but with the possibility of loss of contact with the ground by radio on account of static, it is highly important for the pilot to understand something of the factors governing winds at high elevations.

Actual pressure gradients at 5,000 feet are plotted for a large number of elevated stations in the West; gradients obtained from aerographic flights in the morning are used in connection with the 10,000- and 14,000-foot wind aloft charts. At other periods of the day stream lines on the upper-air charts are of great help in depicting air flow and in bridging the gaps in wind-aloft reports caused by cloudiness.

This zone of icing and turbulence increases in thickness with the strength of the wind, but the top is generally below 12,000 feet. The zone extends horizontally from the crest 20 to 30 miles to windward and half that distance to leeward. Snow, fog, and zero ceilings prevail along the western slope of the mountains; the clouds which occur in several strata over the valleys come together over the mountains and rise to great heights, so that instrument flying is necessary.

The success of winter-flying operations under these conditions depends to a large extent upon the happy circumstance that usually dynamic heating of the air descending the eastern slopes of the higher ranges produces broken cloud layers, with ceiling and visibility favorable for take-off and landing at points in this area.

Aircraft icing seldom occurs below 5,000 or 6,000 feet along the Pacific coast, because of the relatively high temperatures of Pacific air masses usually moving across this area; in fact, the normal winter temperature along the central California coast is above freezing at all levels below 9,500 feet, with an average of 50° F. at 1,000 feet and 40° F. at 6,500 feet.

But even with these relatively high-average winter temperatures along the coast, the freezing line frequently lowers to an elevation of 6,000 to 7,000 feet along the mountains, as a result of the adiabatic cooling of the rising air streams in passing over them.

Before the advent of commercial aviation, the present Chief of the Weather Bureau, W. R. Gregg, discussed clearly the connection between steep latitudinal temperature gradients and unusually strong westerly winds aloft (6). However, the experience of pilots in being forced to high altitudes on account of bad weather below, and there caught in a gale which carried them far off course, shows the need of emphasizing this well-known fact. It follows that when extreme cold prevails in the north and relatively high temperatures to the south, the pilot should be on guard against the possibility of being carried off course by the strong winds which are almost certain to be blowing at high elevations.

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NOTES AND REVIEWS

A Design for a Geostrophic Wind Scale. By STEPHEN LICHTBLAU. The geostrophic wind scale is an important tool which can be used to considerable advantage in the construction of maps over ocean regions. The scale here presented, figure 1, is designed for four different latitudes, and of such dimensions that it may be applied directly to the *"Map A Pacific"*, the base map used at the San Francisco Weather Bureau office. The scale of this map is approximately 1:1.5×10⁷. The wind scale may be made applicable to any other map by reducing or enlarging it in the ratio between the scale of *"Map A Pacific"* and that of the other map.

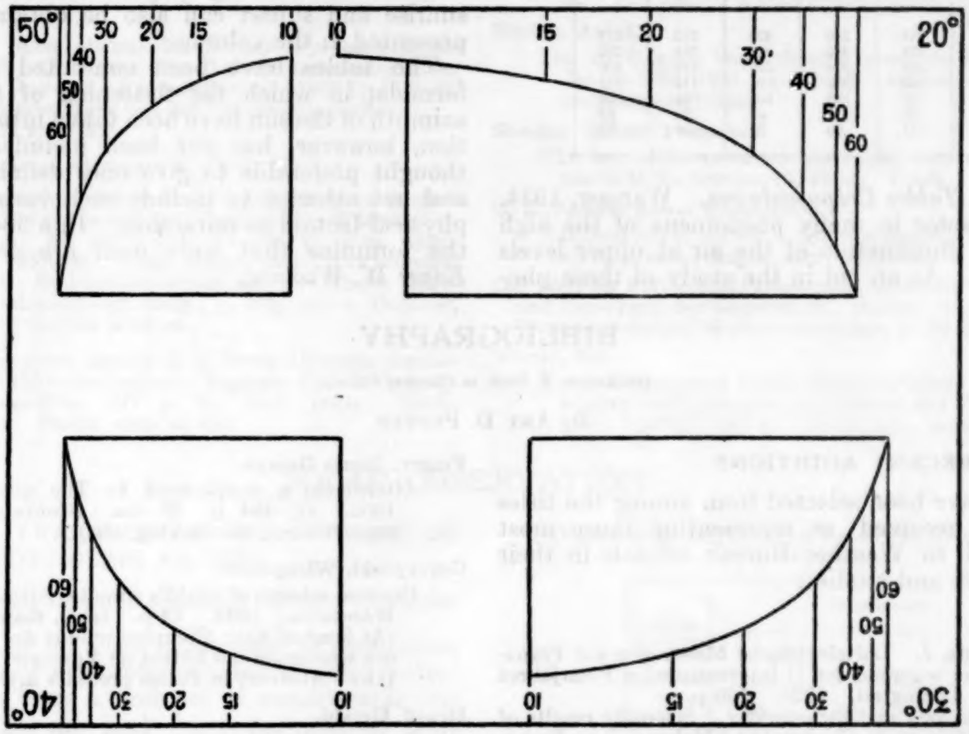

FIGURE 1.

It should be remembered that the geostrophic wind scale applies only to rectilinear motion, and does not take into account the curvature of the trajectory of the air; but the error thus introduced is not important for most extratropical disturbances. The nomogram in Humphreys' *Physics of the Air* shows graphically the effect that the curvature of the path has on the gradient wind. The reduction of speed by frictional influences, which varies between 20 and 30 percent, is also neglected.

If this scale is to be used in daily synoptic analysis, it is advisable that it be transferred to a transparent material such as celluloid.

The scale will determine the correct distance between isobars, which is important in ocean regions where few reports are available: The right or the left edge of the scale (depending upon the latitude) is placed parallel to the wind, and through the position of the ship that sent the report. The distance between the ship and a point where the pressure is one-tenth inch higher or lower is then obtained from the curved scale, at the wind velocity corresponding to that observed. In this manner the positions of several isobars on either side of the ship may be extrapolated if necessary.

It is also possible to determine the movements of fronts at sea with the scale: For this purpose the scale is used between two adjacent isobars at and in the rear of the front. A line parallel to the ruled lines through one of the isobars (the edge of the scale being placed on the other isobar) will give the direction of the movement of the front, while the intersection of the line with the curve will give the magnitude of the movement for a 6-hour period; figure 2 explains the procedure.

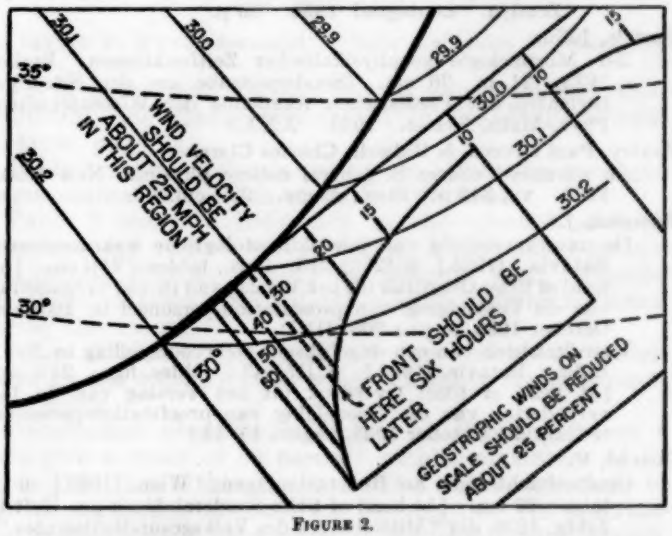

FIGURE 2.

A table is included for the use of anyone who desires to make a scale rather than to reproduce the one presented here; the tabular values are the abscissae of the geostrophic wind scale in miles.

Speed	Ordinates	Latitude 20°	30°	40°	50°	60°
M. p. h.	*Miles*					
10	60	788	540	420	352	312
15	90	524	360	280	234	192
20	120	394	270	210	176	156
30	180	262	180	140	117	104
40	240	197	135	105	88	78
50	300	158	108	84	70	62
60	360	131	90	70	59	52

JEAN LUGEON. *Tables Crépusculaires.* Warsaw, 1934. An important factor in many phenomena of the high atmosphere is the illumination of the air at upper levels by solar radiation. As an aid in the study of these phenomena this volume of tables has been prepared. The tables give the vertical height above the surface of the earth of the lower limit of the illuminated region for different latitudes of the observer and different declinations and hour angles of the sun. This quantity is the distance from the surface of the earth to the point where the perpendicular to the surface is intersected by the solar rays that are just grazing the earth below the horizon. These tables cover 438 large pages. Incidentally, the times of sunrise and sunset can also be obtained from the data presented in the volume.

The tables have been computed from an accurate formula, in which the flattening of the earth and the azimuth of the sun have been taken into account. Refraction, however, has not been included, because it was thought preferable to give only definite geometric data, and not attempt to include such variable and uncertain physical factors as refraction. In a 38-page introduction, the formulae that were used are derived in detail.—*Edgar W. Woolard.*

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[RICHMOND T. ZOCH, *in Charge of Library*]

By AMY D. PUTNAM

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SOLAR OBSERVATIONS

CORRECTIONS TO TRANSMISSION COEFFICIENTS OF SCHOTT-GLASS FILTERS

By HERBERT H. KIMBALL, Research Assistant, Harvard University

The transmission of the glass filters used in connection with determinations of atmospheric turbidity and water-vapor content have been a problem of considerable importance. Both Fuessner and Ångström warned that different samples of these screens would probably have different transmission coefficients, principally because of the fact that they do not all cut off the spectrum at exactly the same wave length.

Investigations in the United States, especially by the National Bureau of Standards, led to the conclusion that a temperature correction should be applied to the transmission coefficients. In the heading of table 3 the corrections for the transmissions of the screens are always followed by +C. The transmissions that have been used for different temperatures of the screens are given in the first column of the following table; and new determinations for each screen are given in the second column. The new values were determined from very excellent curves obtained by the Colorimetry Section, National Bureau of Standards, with a recording spectrophotometer; it is hoped the National Bureau of Standards will publish these curves.

The determination of the new temperature coefficients was not completed in time to determine the turbidities and water-vapor contents of the atmosphere from the radiation measurements obtained at Blue Hill during March 1937. In their determination from the old transmissions, a presistent difference in the results from the two screens appeared, that required an investigation. These data, as determined by means of the new transmission factors, will be published in the April REVIEW.

Transmission coefficients of Schott-glass screens at different temperatures

Temperature °C.	Transmission			
	OG_1		RG_2	
+15	0.852	0.890	0.841	0.878
20	.851	.889	.840	.878
25	.850	.888	.839	.877
30	.849	.887	.838	.877
35	.848	.886	.837	.876
40	.847	.885	.836	.876

SOLAR RADIATION OBSERVATIONS DURING MARCH 1937

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments employed and their exposures, the reader is referred to the January 1935 REVIEW, page 24.

Table 1 shows that solar radiation intensities averaged above normal for March at all four stations.

Table 2 shows a deficiency in the amount of total solar and sky radiation received on a horizontal surface at Lincoln, Fresno, Twin Falls, Miami, and Riverside. All other stations received more than normal radiation during the month.

Table 3 shows comparatively low values of water-vapor on the 4 days during which turbidity measurements were made.

Polarization observations taken at Washington on 6 days give a mean of 56 percent with a maximum of 62 percent on the 17th. Both of these values are close to the corresponding normals for the month. No polarization measurements were made at Madison during March.

TABLE 1.—*Solar radiation intensities during March 1937*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	8 a. m. 75th mer. time	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon Local mean solar time
		A. M.					P. M.				
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm
Mar. 1	2.36	......	......	0.91	1.18	1.48	1.18	1.01	0.86	0.74	1.60
Mar. 2	2.74	......	0.79	1.04	1.22	1.44	......	......	......	......	2.62
Mar. 3	3.63	......	......	.84	......	......	......	......	......	......	3.15
Mar. 4	4.37	......	......	.89	1.18	1.58	......	......	......	......	4.57
Mar. 10	1.78	......	......	.98	1.29	......	......	......	......	......	1.52
Mar. 16	2.62	......	......	.89	1.06	......	......	......	......	......	2.36
Mar. 17	2.74	......	......	......	1.20	1.64	1.23	1.02	.92	.79	2.36
Means	......	......	(.79)	.93	1.16	1.54	(1.20)	(1.02)	(.89)	(.76)	......
Departures	......	......	−.02	−.01	+.01	+.11	+.06	+.08	+.10	+.06	......

MADISON, WIS.

Date	8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
Mar. 2	3.15	0.79	0.98	1.13	1.36	......	......	......	......	......	3.30
Mar. 16	2.49	.86	1.00	1.17	1.34	1.66	......	......	......	......	2.36
Mar. 18	3.81	......	......	......	1.27	1.67	1.31	......	......	......	3.15
Mar. 19	2.87	.89	1.00	1.12	......	......	......	......	......	......	3.45
Mar. 25	1.24	......	......	......	1.27	1.66	......	......	......	......	1.24
Mar. 26	.96	.97	1.06	1.23	1.39	1.61	1.30	......	......	......	1.32
Mar. 29	2.36	.86	.98	1.15	1.33	1.61	1.41	......	......	......	1.88
Means	......	.87	1.00	1.16	1.33	1.64	1.34	......	......	......	......
Departures	......	−.04	−.02	.00	+.02	+.05	+.05	......	......	......	......

LINCOLN, NEBR.

Date	8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
Mar. 1	2.62	......	0.86	0.96	1.41	......	1.49	1.33	1.20	1.00	3.15
Mar. 5	4.57	......	.96	1.18	1.36	1.70	1.39	1.24	1.13	......	4.95
Mar. 8	3.63	......	1.19	1.30	......	......	......	......	......	......	3.15
Mar. 11	2.87	......	......	......	......	1.61	1.38	1.17	1.01	.87	3.45
Mar. 15	1.60	......	.92	1.11	1.34	1.63	1.32	1.10	.95	......	1.45

TABLE 1.—*Solar radiation intensities during March 1937*—Con.

[Gram-calories per minute per square centimeter of normal surface]

LINCOLN, NEBR.—Continued

Date	8 a. m. 75th mer. time	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon Local mean solar time
		A. M.					P. M.				
	e	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e
	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm
Mar. 18	3.00	......	......	.97	1.20	1.65	......	......	......	......	2.87
Mar. 20	3.30	......	......	1.19	1.37	1.63	......	......	......	......	4.37
Means	......	......	.98	1.12	1.34	1.64	1.40	1.21	1.07	(.94)	......
Departures	......	......	+.04	+.03	+.06	+.09	+.12	+.12	+.13	+.13	......

BLUE HILL, MASS.

Date	8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
Mar. 1	1.5	......	......	......	1.40	1.42	1.23	0.99	0.89	......	1.4
Mar. 2	2.6	......	0.79	0.94	1.05	1.14	......	......	......	......	3.2
Mar. 3	1.9	......	......	1.18	1.35	1.52	1.31	1.20	1.12	1.02	1.8
Mar. 7	.8	1.10	1.21	1.33	1.45	1.61	1.45	1.32	1.22	1.12	.8
Mar. 10	1.1	......	......	1.32	1.44	......	......	......	......	......	.9
Mar. 11	1.5	......	.84	.96	1.08	1.26	......	......	......	......	1.4
Mar. 12	1.9	......	......	......	......	1.40	1.09	.96	.85	.73	2.3
Mar. 18	3.0	......	......	......	......	1.21	......	......	......	......	2.6
Mar. 19	4.4	......	......	......	1.12	1.24	1.03	......	......	......	......
Mar. 20	3.5	......	.85	.95	1.05	1.16	......	......	......	......	3.2
Mar. 22	2.9	......	......	1.09	1.28	1.51	1.32	1.12	.94	.72	2.3
Mar. 23	2.2	......	......	......	1.26	1.43	1.34	......	......	......	2.1
Mar. 24	2.8	......	......	1.10	1.27	1.43	1.30	1.18	......	......	2.1
Mar. 26	2.0	......	......	......	1.21	1.39	......	......	......	......	2.0
Mar. 27	2.5	......	......	......	1.30	1.41	......	......	......	......	2.5
Mar. 28	2.1	......	......	......	......	1.41	1.30	1.18	1.06	.95	1.9
Mar. 29	3.0	......	......	......	1.30	1.50	1.31	1.12	.98	.88	3.1
Mar. 30	2.2	......	1.00	1.16	1.32	1.52	1.32	1.16	1.00	.87	2.5
Mar. 31	1.8	......	......	......	......	1.43	1.20	......	......	......	2.4
Means	......	(1.10)	.94	1.11	1.26	1.39	1.27	1.14	1.01	.90	......
Departures	......	+.24	+.01	+.02	+.04	−.01	+.07	+.10	+.05	+.04	......

* Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	San Juan	Friday Harbor	Ithaca
	Gram-calories per square centimeter															
	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Feb. 26	326	198	292	188	315	433	145	302	473	383	278	450	364	528	340	285
Mar. 5	368	328	426	207	218	413	156	392	403	305	360	430	275	521	267	224
Mar. 12	270	405	291	262	212	369	216	281	384	430	381	321	232	514	256	223
Mar. 19	286	324	261	218	328	365	219	332	516	431	319	419	360	567	275	248
Mar. 26	450	458	315	318	497	495	312	368	503	390	334	500	513	539	......	345
	Departures from weekly normals															
Feb. 26	+36	−79	−48	−19	+67	+34	−2	−4	......	+16	−1	+42	+56	......	+58	+52
Mar. 5	+56	+28	+69	−3	−41	+10	+3	+48	......	−61	+64	+13	−55	......	−2	−4
Mar. 12	−53	+88	−82	+43	−55	−39	+19	−72	......	+8	+49	−83	−82	......	+64	−19
Mar. 19	−45	+6	−127	−22	+39	−87	+39	−52	......	−50	−38	−79	+4	......	+21	−39
Mar. 26	+108	+103	−87	+72	+212	+11	+27	+24	......	−67	+30	−71	+125	......	......	+45
	Accumulated departures on Apr. 1															
	−2,625	+728	−1,631	+903	+1,701	+651	+413	−665		−2,016	+1127	−1,687	−1,988	......	+1,869	+1,372

ON THE METHOD EMPLOYED FOR COMPUTING β AND W, SEE P. 61 OF THE FEBRUARY 1937 REVIEW.—ED.

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during March 1937 and determinations of the atmospheric turbidity factor, β, and water-vapor content, w = depth in millimeters, if precipitated*

AMERICAN UNIVERSITY, WASHINGTON, D. C.

Date and hour angle	Solar altitude		Air mass	I_m	I_y	I_r	(*) $\frac{I_y}{.851+C}$	(*) $\frac{I_r}{.840+C}$	β mean I_m-I_r and I_y-I_r	(*) $\frac{I_{w=0}}{1.94}$	(*) $\frac{I_{w=0}-I_m}{1.94}$	w	Air-mass type
										Percentage of solar constant			
	°	′	m	gr. cal.	gr. cal.	gr. cal.	gr. cal.	gr. cal.				mm	
Mar. 1:													
0:53 p. m.	42	23	1.48	1.312	0.920	0.754	1.070	0.876	0.085	73.7	7.3	3.4	Pc.
0:57 p. m.	42	18	1.48	1.306	.921	.755	1.071	.877	.088	73.4	7.3	3.4	
Mar. 16:													
3:06 a. m.	30	46	1.95	1.095	.849	.703	.995	.824	.128	61.6	5.7	1.8	Pc.
3:02 a. m.	31	36	1.90	1.124	.850	.704	.996	.825	.138	61.4	4.1	1.1	
Mar. 17:													
3:17 a. m.	29	48	2.01	1.184	.882	.697	1.045	.824	.076	68.0	7.0	2.6	Pc.
3:13 a. m.	29	19	2.04	1.193	.883	.698	1.046	.825	.070	69.4	8.0	3.4	
Mar. 19:													
2:50 a. m.	34	38	1.76	1.107	.836	.677	.989	.800	.068	65.6	8.6	4.4	NP.
2:46 a. m.	26	07	1.69	1.104	.838	.679	.992	.802	.070	65.4	8.5	4.4	

* Values reduced to mean solar distance.

Atmospheric conditions during turbidity measurements

Mar. 1. Temperature 8° C., wind, NW 13; polarization, 57.4 percent; visibility, 20 miles; blueness of sky, 5.
Mar. 16. Temperature 2° C., wind, NW 27; polarization, 51.6 percent; visibility, 12 miles; blueness of sky, 4.
Mar. 17. Temperature 5° C., wind, NW 26; polarization, 62.3 percent; visibility, 50 miles; blueness of sky, 6.
Mar. 19. Temperature 8° C., wind, NW 23; polarization, 48.9 percent; visibility, 5 miles; blueness of sky, 3.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time		Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot	Area: Group	Total area for each day	Observatory
1937	h	m	°	°	°				
Feb. 1	13	16	−54.0	120.0	+19.0	73			U. S. Naval.
			−47.5	126.5	−16.0		61		
			−41.0	133.0	+24.0		121		
			−37.5	136.5	+26.0		97		
			−28.0	146.0	+34.0	48			
			−21.0	153.0	−20.0		121		
			+13.0	187.0	+17.5	24			
			+16.5	190.5	−21.5		291		
			+18.0	192.0	+ 7.5	61			
			+23.0	197.0	−11.0		2,424		
			+27.0	201.0	+25.5		97		
			+31.0	205.0	+18.5		291		
			+47.0	221.0	+22.0		242		
			+50.5	224.5	−20.5	85		4,036	
Feb. 2	11	32	−41.0	120.8	+19.5	97			Do.
			−34.0	127.8	−15.5		73		
			−30.0	131.8	+24.0		145		
			−25.0	136.8	+26.5		97		
			−15.5	146.3	+34.0	48			
			− 9.0	152.8	−19.0		218		
			+ 1.0	162.8	−31.5	61			
			+16.0	177.8	−14.5		121		
			+29.0	190.8	−21.5		339		
			+30.0	191.8	+ 8.0	61			
			+36.0	197.8	−10.5		2,182		
			+40.0	201.8	+25.0	97			
			+46.0	207.8	+18.5		242		
			+59.5	221.3	+23.0		242		
			+63.0	224.8	−20.5	97		4,120	
Feb. 3	11	11	−72.0	76.8	−11.0		170		Do.
			−69.0	79.8	+18.5	145			
			−29.5	119.3	+19.0	73			
			−21.0	127.8	−16.0		48		
			−18.0	130.8	+23.0		97		
			−11.0	137.8	+26.0		73		
			− 4.0	144.8	+33.0	24			
			+ 4.5	153.3	−19.0		267		
			+15.0	163.8	−32.5	48			
			+30.0	178.8	−15.0		48		
			+41.0	189.8	−23.0		291		
			+43.0	191.8	+ 7.0	61			
			+49.0	197.8	−10.5		1,842		
			+51.0	199.8	+24.5	48			
			+60.0	208.8	+18.0	194			
			+69.0	217.8	+24.0	97			
			+78.0	226.8	+22.0	145			
			+78.0	226.8	−21.0	97		3,768	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time		Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot	Area: Group	Total area for each day	Observatory
1937	h	m	°	°	°				
Feb. 4	11	15	−70.0	65.6	−22.0		131		Mount Wilson.
			−58.0	77.6	−10.0		89		
			−55.0	80.6	+20.0		78		
			−18.0	117.6	+19.5	66			
			− 8.0	127.6	−16.0		49		
			− 5.0	130.6	+23.0		119		
			+ 2.0	137.6	+28.0		15		
			+ 9.0	144.6	+32.0		11		
			+18.0	153.6	−18.0		271		
			+26.0	161.6	−32.0		43		
			+42.0	177.6	−15.0		19		
			+50.0	185.6	+10.0		6		
			+53.0	188.6	−22.0		311		
			+56.0	191.6	+ 8.0	78			
			+61.0	196.6	− 9.0		1,582		
			+66.0	201.6	+24.0	46			
			+72.0	207.6	+18.0	155		3,071	
Feb 5	11	17	−57.0	65.4	−22.0		194		Do.
			−50.0	72.4	+18.0	48			
			−46.5	75.9	−11.0	12			
			−41.5	80.9	+18.0		48		
			−40.5	81.9	−11.0	61			
			−3.0	119.4	+19.0	48			
			+5.0	127.4	−17.0		48		
			+9.0	131.4	+23.5		97		
			+13.0	135.4	+26.5	24			
			+21.0	143.4	+30.0	12			
			+30.5	152.9	−19.0		145		
			+40.0	162.4	−26.0	12			
			+56.0	178.4	−15.0		36		
			+60.0	182.4	−30.0		48		
			+66.0	188.4	−23.0		485		
			+69.0	191.4	+10.0	73			
			+76.0	198.4	−10.5		1,600	2,981	
Feb. 6	11	10	−43.0	66.3	−21.5		194		Do.
			−39.0	70.3	+19.0	48			
			−28.5	80.8	+19.0		73		
			−28.0	81.3	−11.0	73			
			+9.5	118.8	+19.0	48			
			+21.0	130.3	+22.0		97		
			+44.0	153.3	−19.0		97		
			+53.0	162.3	−26.0		85		
			+70.0	179.3	−15.0	24			
			+73.0	182.3	−30.5		100		
			+80.0	189.3	−23.0	412			
			+87.0	196.3	−10.5	145		1,405	
Feb. 7	11	34	−70.0	25.9	−4.0	32			Mount Wilson.
			−27.0	68.9	−21.0		44		
			−19.0	76.9	+19.0		32		
			−14.0	81.9	−10.0	21			
			+23.0	118.9	+20.0	16			
			+35.0	130.9	+23.0	24			
			+55.0	150.9	−18.0		47		
			+62.0	157.9	−25.0		37	253	

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot	Area: Group	Total area for each day	Observatory
1937	h m	°	°	°				
Feb. 8	12 15	−58.0	24.4	−5.0	91			Mount Wilson.
		−55.0	27.4	+15.0		79		
		−16.0	66.4	−22.0		37		
		−6.0	76.4	+18.0		19		
		−2.0	80.4	−12.0		38		
		+35.0	117.4	+19.0		9		
		+48.0	130.4	+22.0		12		
		+60.0	142.4	+21.0		34		
		+70.0	152.4	−19.0		62		
		+79.0	161.4	−26.0		59	440	
Feb. 9	12 0	−45.0	24.3	−5.0	69			Do.
		−38.0	31.3	+17.5		90		
		−22.0	47.3	+21.0		70		
		0.0	69.3	−22.0		18		
		+7.0	76.3	+18.0		20		
		+12.0	81.3	−12.0		21		
		+52.0	121.3	+19.0	50			
		+65.0	134.3	+22.0	42		380	
Feb. 10	11 36	−30.0	26.4	−6.0	61			U. S. Naval.
		−25.0	31.4	+15.0		170		
		−6.0	50.4	+20.0		242		
		+13.0	69.4	−21.0		36		
		+63.0	119.4	+17.5	24		533	
Feb. 11	11 24	−20.5	22.8	+9.5		73		Do.
		−17.0	26.3	−7.0	48			
		−11.0	32.3	+16.0		121		
		+3.0	46.3	+20.0		145		
		+10.5	53.8	+20.0	242		629	
Feb. 12	12 1	−79.5	310.3	+15.0	242			Do.
		−5.0	24.8	+10.0		48		
		−3.0	26.8	−7.0	48			
		+3.0	32.8	+16.5		121		
		+17.5	47.3	+20.5		194		
		+22.0	51.8	+20.0		242		
		+40.0	69.8	−21.0		48	943	
Feb. 13	12 9	−64.0	312.6	+15.0	242			Do.
		+9.0	25.6	+10.0		145		
		+10.0	26.6	−7.0	48			
		+17.5	34.1	+16.5		145		
		+33.5	50.1	+21.0		436		
		+50.5	67.1	−21.0	48		1,064	
Feb. 14	12 20	−50.0	313.3	+14.0	242			Do.
		+22.0	25.3	+10.5		291		
		+24.0	27.3	−6.0	48			
		+26.0	29.3	+16.0		24		
		+29.0	32.3	+10.5	12			
		+32.0	35.3	+17.0	194			
		+46.0	49.3	+20.5		533		
		+67.0	70.3	−20.5		36	1,380	
Feb. 15	14 48	−68.0	280.8	+21.5	24			Do.
		−35.0	313.8	+14.5	242			
		+36.0	24.8	+11.0		388		
		+39.0	27.8	−6.0	36			
		+47.0	35.8	+17.0	145			
		+60.5	49.3	+20.5		436	1,271	
Feb. 16	11 40	−75.0	262.3	+21.0		400		Mount Wilson.
		−57.0	280.3	+22.0	29			
		−24.0	313.3	+15.0		328		
		+7.0	344.3	−28.0		38		
		+50.0	27.3	+12.0		362		
		+51.0	28.3	−5.5		22		
		+60.0	37.3	+18.0	136			
		+70.0	47.3	+21.0		246		
		+79.0	56.3	−34.0		39	1,600	
Feb. 17	11 10	−66.0	258.5	+21.5		970		U. S. Naval.
		−41.0	283.5	+21.0	24			
		−11.0	313.5	+15.0		291		
		+19.0	343.5	−28.0		36		
		+63.0	27.5	−6.0	12			
		+63.0	27.5	+10.5		339		
		+72.0	36.5	+16.0	194		1,866	
Feb. 18	12 20	−85.0	225.7	−10.5	88			Mount Wilson.
		−78.0	232.7	+16.0		435		
		−55.0	255.7	+22.0		799		
		−30.0	280.7	+23.0		13		
		+3.0	313.7	+15.0		121		
		+32.0	342.7	−28.0		9		
		+73.0	23.7	+12.0		254		
		+76.0	26.7	−6.5	10		1,729	
Feb. 19	12 0	−73.0	224.7	−10.0		73		U. S. Naval.
		−68.0	229.7	+17.0		873		
		−40.0	257.7	+21.0		1,018		
		−21.5	276.2	+20.5	12			
		−15.0	282.7	+22.0	12			
		+16.0	313.7	+15.0		145	2,133	
Feb. 20	13 35	−80.0	203.7	−11.0	83			Mount Wilson.
		−75.0	208.7	+13.0	15			
		−72.0	211.7	+20.0		305		
		−55.0	228.7	−11.0	70			
		−54.0	229.7	+15.0		716		
		−30.0	253.7	+21.0		855		
		−6.0	277.7	+20.0		46		
		+31.0	314.7	+15.0	109		2,199	
Feb. 21	13 30	−79.0	191.5	+27.0	75			Do.
		−68.0	202.5	−11.0	217			
		−60.0	210.5	+14.0		19		
		−60.0	210.5	+21.0		250		
		−43.0	227.5	−10.0	82			
		−40.0	230.5	+16.0		353		
		−17.0	253.5	+22.0		653		
		+5.0	275.5	+20.0		39		

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot	Area: Group	Total area for each day	Observatory
1937	h m	°	°	°				
Feb. 21	13 30	+44.0	314.5	+16.0	128		1,816	Mount Wilson.
Feb. 22	12 44	−77.0	180.8	−24.0	194			U. S. Naval.
		−65.0	192.8	+28.0	73			
		−55.0	202.8	−10.5	218			
		−45.0	212.8	+13.0		24		
		−45.0	212.8	+21.0		194		
		−33.0	224.8	+17.5		339		
		−30.0	227.8	−10.5	73			
		−21.0	236.8	+16.0		291		
		−5.0	252.8	+21.0		485		
		+6.0	263.8	+21.0		145		
		+19.5	277.3	+19.5		48		
		+48.0	305.8	−13.0		48		
		+58.0	315.8	+14.5	61		2,193	
Feb. 23	11 54	−63.0	182.0	−25.0	194			Do.
		−61.0	184.0	+19.5		121		
		−51.0	194.0	+28.0	97			
		−41.0	204.0	−10.5	218			
		−34.0	211.0	+12.0		73		
		−33.0	212.0	+21.0		145		
		−19.5	225.5	+17.0		339		
		−17.5	227.5	−10.5	73			
		−9.5	235.5	+15.0		388		
		+6.0	251.0	+21.0		582		
		+21.0	266.0	+21.0		97		
		+36.0	281.0	+20.0	36			
		+70.0	315.0	+15.0	97		2,460	
Feb. 24	12 7	−73.0	158.8	+10.0	582			Do.
		−54.0	177.8	−13.0	48			
		−50.0	181.8	+19.5		194		
		−49.5	182.3	−25.0	194			
		−39.0	192.8	+28.0	73			
		−28.5	203.3	−10.5	218			
		−19.0	212.8	+21.0		121		
		−6.0	225.8	+16.5		291		
		−4.0	227.8	−10.5	48			
		+4.0	235.8	+15.5		339		
		+20.0	251.8	+21.0		485		
		+35.0	266.8	+20.0		48	2,641	
Feb. 25	13 30	−63.0	154.8	+10.0		630		Do.
		−39.5	178.3	−11.5	61			
		−37.0	180.8	−25.0	194			
		−37.0	180.8	+19.0		145		
		−25.0	192.8	+28.0	97			
		−13.0	204.8	−10.5	218			
		−5.0	212.8	+12.0		24		
		−5.0	212.8	+20.5		97		
		+7.0	224.8	+17.0		194		
		+10.0	227.8	−10.5	48			
		+19.0	236.8	+17.0		242		
		+33.0	250.8	+21.0		291	2,241	
Feb. 26	11 18	−50.0	155.9	+9.5		776		Do.
		−33.0	172.9	−23.0		36		
		−27.5	178.4	−12.0	36			
		−25.0	180.9	+19.0		61		
		−24.5	181.4	−26.0	194			
		−13.0	192.9	+28.0	73			
		−1.0	204.9	−10.5	218			
		+9.0	214.9	+12.0		24		
		+10.0	215.9	+19.5		48		
		+19.5	225.4	+17.0		145		
		+21.0	226.9	−11.0	48			
		+30.0	235.9	+17.0		194		
		+45.0	250.9	+21.0		242	2,095	
Feb. 27	13 20	−34.0	157.6	+9.5		824		Do.
		−18.0	173.6	−24.0		48		
		−15.0	176.6	+12.0		24		
		−10.0	181.6	+18.0	61			
		−10.0	181.6	−26.0	194			
		−9.0	182.6	+9.0	24			
		+0.5	192.1	+28.0		48		
		+8.0	199.6	+12.0	24			
		+12.0	203.6	−10.5	218			
		+19.0	210.6	+12.0		97		
		+23.0	214.6	+20.0	36			
		+33.0	224.6	+17.0		145		
		+36.0	227.6	−11.0	48			
		+43.0	234.6	+17.0		194		
		+57.0	248.6	+21.0		194	2,179	
Feb. 28	12 50	−69.0	109.7	−25.0	11			Mount Wilson.
		−56.0	122.7	−17.0	4			
		−26.0	152.7	−25.0		6		
		−18.0	160.7	+9.0		788		
		−1.0	177.7	+12.0	3			
		−1.0	177.7	−11.0		6		
		+2.0	180.7	−26.0		178		
		+3.0	181.7	+18.0		45		
		+4.0	182.7	+9.0		5		
		+14.0	192.7	+27.0	10			
		+22.0	200.7	+12.0		24		
		+23.0	201.7	−16.0		12		
		+26.0	204.7	−10.0		177		
		+34.0	212.7	+13.0		69		
		+38.0	216.7	+21.0	29			
		+49.0	227.7	−10.5		33		
		+53.0	231.7	+18.0		150		
		+59.0	237.7	−20.0		85		
		+72.0	250.7	+23.0	102		1,737	

Mean daily area for 28 days, 1,899.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent, U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time	Heliographic			Area		Total area for each day	Observatory
		Diff. in longitude	Longitude	Latitude	Spot	Group		
1937	h. m.	°	°	°				
Mar. 1	11 53	−14.0	152.0	−25.0		48		U. S. Naval.
		−6.0	160.0	+10.0		873		
		+8.5	174.5	−25.0		255		
		+14.5	180.5	+19.5	48			
		+37.0	203.0	−10.0		218		
		+41.0	207.0	+12.5		73		
		+50.0	216.0	+20.0	24			
		+60.0	226.0	+17.0	97			
		+61.0	227.0	−11.0	48			
		+70.0	236.0	+16.5	121			
		+73.0	239.0	−21.0		388	2,193	
Mar. 2	11 3	+0.5	153.8	−25.0	24			Do.
		+7.0	160.3	+10.0		970		
		+21.0	174.3	−25.0		388		
		+28.0	181.3	+30.0	12			
		+28.0	181.3	+19.5	48			
		+51.0	204.3	−10.5		206		
		+55.0	208.3	+13.0		73		
		+62.0	215.3	+20.0	12			
		+72.0	225.3	+16.5	97			
		+73.0	226.3	−11.5	48			
		+86.0	239.3	−22.0	12		1,890	
Mar. 3	11 12	+14.0	154.0	−25.0	12			Do.
		+21.0	161.0	+9.5		921		
		+29.0	169.0	−23.0		48		
		+39.0	179.0	−25.5		145		
		+40.0	180.0	+20.0	24			
		+40.5	180.5	+30.0		48		
		+65.0	204.0	−10.0	194		1,392	
Mar. 4	11 18	−75.0	51.8	+11.0	97			Do.
		−55.0	71.8	+20.0		145		
		−53.0	73.8	−30.0		61		
		+34.5	161.3	+9.5		776		
		+41.0	167.8	−24.0	48			
		+51.0	177.8	−25.5		97		
		+51.0	177.8	+30.5	48			
		+79.0	205.8	−10.5	145		1,417	
Mar. 5	11 6	−65.0	48.7	+11.0		145		Do.
		−41.5	72.2	+20.0		339		
		−40.5	73.2	−30.0		121		
		+49.0	162.7	+9.5		679	1,284	
Mar. 6	11 14	−65.0	35.5	+9.5	24			Do.
		−50.5	50.0	+11.0		170		
		−28.0	72.5	+19.5		679		
		−27.0	73.5	−30.0		97		
		+62.0	162.5	+9.5		533	1,503	
Mar. 7	10 55	−50.0	37.5	+10.0	12			Do.
		−42.0	45.5	+14.0		73		
		−38.0	49.5	+11.0		121		
		−14.0	73.5	+20.0		533		
		−13.0	74.5	−30.0		97		
		+78.0	165.5	+9.0	485		1,321	
Mar. 8	14 7	−63.0	9.6	+13.0		97		Do.
		−49.5	23.1	+17.0		73		
		−39.0	33.6	+9.5	6			
		−30.5	42.1	+24.0		73		
		−23.0	49.6	+12.0		97		
		0.0	72.6	+20.0		533		
		+3.5	76.1	−29.5	97			
		+48.0	120.6	−19.0		97	1,073	
Mar. 9	9 37	−52.0	9.9	+14.0		145		Mount Wilson.
		−43.0	18.9	+31.0		145		
		−42.0	19.9	+12.0	36			
		−37.0	24.9	+17.0		61		
		−25.0	36.9	+9.5	12			
		−20.5	41.4	+24.0		61		
		−10.5	51.4	+11.5	48			
		+10.0	71.9	+19.5		582		
		+16.0	77.9	−29.5	97			
		+57.0	118.9	−19.5		109	1,296	
Mar. 10	11 12	−37.0	10.8	+13.0		97		U. S. Naval.
		−31.0	16.8	+31.0	24			
		−28.0	19.8	+11.5	48			
		−24.0	23.8	+30.0	61			
		−6.0	41.8	+24.0		48		
		+3.0	50.8	+12.0	61			
		+20.0	67.8	+21.0		97		
		+30.0	77.8	+19.5	291			
		+30.5	78.3	−29.0	97			
		+73.0	120.8	−19.5		97	921	
Mar. 11	12 14	−25.0	9.1	+13.0		145		Do.
		−15.0	19.1	+11.0		48		
		−10.0	24.1	+29.5	48			
		+6.0	40.1	+25.0	12			
		+10.0	44.1	+22.0	12			
		+18.0	52.1	+11.5		48		
		+33.0	67.1	+21.0		48		
		+43.0	77.1	+19.5	436			

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Heliographic			Area		Total area for each day	Observatory
		Diff. in longitude	Longitude	Latitude	Spot	Group		
1937	h. m.	°	°	°				
Mar. 11	12 14	+46.0	80.1	−29.5	121		918	U. S. Naval.
Mar. 12	10 56	−13.0	8.6	+13.0		121		
		−6.0	15.6	+32.0	36			
		−2.5	19.1	+30.0	36			
		−2.0	19.6	+10.5	24			
		+2.5	24.1	+29.5	36			
		+30.0	51.6	+11.0		48		
		+56.0	77.6	+19.5	436			
		+59.5	81.1	−29.0	121		858	
Mar. 16	10 53	−22.5	306.4	−23.0		97		Do.
		+44.0	12.9	+15.0		61	158	
Mar. 17	11 13	−11.0	304.5	−22.0		97		Do.
		+58.0	13.5	+15.0		61	158	
Mar. 18	13 45	+3.0	304.0	−23.0	41			Harvard.
		+10.0	311.0	−21.0	83		124	
Mar. 19	12 26	−22.5	266.0	+26.0	48			U. S. Naval.
		+19.5	308.0	−22.0	48		96	
Mar. 20	11 2	−86.0	190.1	+8.0	73			Mount Wilson.
		−70.0	206.1	−10.5	24			
		−69.0	207.1	+6.0	48			
		−69.0	207.1	−16.5	24			
		−13.0	263.1	+24.5		121		
		+31.0	307.1	−22.0	36		326	
Mar. 21	11 35	−76.0	186.6	+10.0	145			Do.
		−69.0	193.6	+8.0	242			
		−57.5	205.1	−11.0	24			
		−56.0	206.6	−18.0		145		
		−3.0	259.6	+24.0	12			
		+2.0	264.6	+25.0		48		
		+45.0	307.6	−22.5	36		652	
Mar. 22	14 56	−83.0	164.6	+8.0	436			U. S. Naval.
		−70.0	177.6	−14.0	97			
		−60.0	187.6	+10.0	71			
		−51.5	196.1	+8.0	121			
		−40.0	207.6	−11.0	24			
		−39.5	208.1	−18.0		48		
		+3.0	250.6	+23.5		48		
		+7.0	254.6	+11.0		48		
		+30.5	278.1	−25.0		97		
		+59.0	306.6	−21.5	48		1,038	
Mar. 23	11 18	−79.0	157.4	+10.0	291			Do.
		−70.0	166.4	+8.0	485			
		−60.0	176.4	−14.5	73			
		−48.0	188.4	+10.0	48			
		−40.0	196.4	+8.0	170			
		−29.5	206.9	−11.0	24			
		−29.0	207.4	−18.0		48		
		+11.0	247.4	+24.0	24			
		+42.0	278.4	−25.0		145		
		+70.0	306.4	−22.0	36		1,344	
Mar. 24	11 7	−66.0	157.3	+10.5		679		Do.
		−57.0	166.3	+7.0	485			
		−54.0	169.3	+17.5		48		
		−46.0	177.3	−15.0	73			
		−26.5	196.8	+7.5	194			
		+55.0	278.3	−25.0		73	1,552	
Mar. 25	11 30	−58.0	151.9	+11.0		388		Do.
		−49.5	160.4	+10.0		194		
		−43.0	166.9	+7.0		485		
		−39.5	170.4	+18.0	24			
		−34.0	175.9	−15.0	73			
		−19.0	190.9	+19.0	24			
		−13.0	196.9	+7.5	109			
		+71.0	280.9	−25.5	61		1,358	
Mar. 26	11 31	−43.0	153.7	+11.0		339		Do.
		−34.5	162.2	+10.0		218		
		−29.5	167.2	+7.0		436		
		−24.0	172.7	+18.0	24			
		−19.0	177.7	−15.0		97		
		−5.5	191.2	+18.5	48			
		+0.5	197.2	+7.5	73			
		+12.0	208.7	−19.5		97	1,333	
Mar. 27	11 7	−75.0	108.7	−8.0	145			Do.
		−30.0	153.7	+11.0		291		
		−20.5	163.2	+9.5		218		
		−16.5	167.2	+7.0		436		
		−13.0	170.7	+18.0		48		
		−6.0	177.7	−14.0		73		
		+9.0	192.7	+19.5		291		
		+14.0	197.7	+7.5		73		
		+26.0	209.7	−19.5		61	1,636	
Mar. 28	12 6	−60.0	110.0	−8.0	121			Do.
		−17.0	153.0	+11.0		291		
		−6.5	163.5	+9.5	206			
		−3.0	167.0	+7.0		388		
		+7.0	177.0	−15.5		97		
		+23.0	193.0	+19.0		388		
		+29.0	199.0	+7.0	48			
		+40.0	210.0	+10.0		73	1,612	
Mar. 29	11 32	−63.0	94.1	+9.5	48			Do.
		−48.0	109.1	−8.5	121			
		−4.0	153.1	+11.0		291		
		+7.0	164.1	+9.5		194		
		+10.5	167.6	+7.0		339		
		+20.5	177.6	−15.0		73		

POSITIONS AND AREAS OF SUN SPOTS—Continued

Date	Eastern standard time	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot	Area: Group	Total area for each day	Observatory
	h. m.	°	°	°				
Mar. 29	11 15	+36.0	193.1	+19.0	-------	436	-------	U. S. Naval.
		+40.5	197.6	+8.0	36	-------	-------	
		+50.0	207.1	+10.0	24	-------	1,562	
Mar. 30	12 14	−56.5	87.1	+15.0	-------	97	-------	
		−49.5	94.1	+9.0	-------	73	-------	
		−33.0	110.6	−9.0	97	-------	-------	
		+10.5	154.1	+11.0	-------	242	-------	
		+20.5	164.1	+9.5	194	-------	-------	
		+24.0	167.6	+7.0	-------	291	-------	
		+36.0	179.6	−15.0	48	-------	-------	
		+44.0	187.6	+17.0	48	-------	-------	
		+50.0	193.6	+20.5	121	-------	-------	
		+54.0	197.6	+19.0	-------	242	1,453	
Mar. 31	11 15	−71.0	59.9	+23.0	145	-------	-------	Do.
		−43.0	87.9	+16.0	-------	170	-------	
		−36.5	94.4	+9.0	-------	97	-------	
		−21.0	109.9	−9.0	-------	97	-------	
		+5.0	135.9	+9.5	-------	145	-------	
		+23.0	153.9	+10.5	-------	170	-------	
		+33.0	163.9	+9.0	242	-------	-------	
		+38.0	168.9	+6.5	-------	242	-------	
		+49.0	179.9	−15.0	48	-------	-------	
		+63.0	193.9	+19.0	-------	242	-------	
		+69.0	199.9	+17.0	194	-------	1,792	

Mean daily area for 28 days, 1,152.

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR MARCH 1937

[Dependent alone on observations at Zurich and its station at Arosa]

[Through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich, Switzerland]

March 1937	Relative numbers	March 1937	Relative numbers	March 1937	Relative numbers
1	*Wac* 154	11	98	21	*Eac* 62
2	*b* 154	12	59	22	*Mc* 74
3	*Ec* 109	13	*a* 41	23	*d* 107
4	*Ecd* 65	14	21	24	*d* ---
5	76	15	20	25	87
6	71	16	*Ec* 23	26	*a* 80
7	*Wc* 105	17	22	27	*Mac* 118
8	*abd* 115	18	*Eac* 37	28	131
9	107	19	33	29	*a* 117
10	99	20	*d* ---	30	*a* 135
				31	*a* 145

Mean, 29 days=85.0.

a=Passage of an average-sized group through the central meridian.
b=Passage of a large group or spot through the central meridian.
c=New formation of a group developing into a middle-sized or large center of activity: E, on the eastern part of the sun's disk; W, on the western part; M, on the central circle zone.
d=Entrance of a large or average-sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE, in charge]

By L. P. HARRISON

Mean free-air data based on airplane weather observations during the month of March 1937 are given in tables 1 to 3. A description of the methods by which the various monthly means and normals therein are computed may be found in this section of the MONTHLY WEATHER REVIEW for January 1937. The "normals" of temperature, pressure, and relative humidity at the 1,500 and 2,500 meter levels for the Navy stations were obtained in a manner slightly different from the usual method. Prior to the year 1934, the data in the columns for 1,500 and 2,500 meters were not computed. It has been found expedient to obtain these data by linear interpolation for the purpose of the present summary.

It will be noted that many of the "normals" are based on only 3 years of observations. Conclusions based on departures from such short-period "normals" must be used with caution.

The mean surface temperatures for March (see chart I) were below normal over the country except in the Pacific coastal States, and Nevada, southern Utah, western Colorado, as well as Idaho, Montana, and North Dakota, where they were generally above normal. The largest negative departures at the surface were largely concentrated in the south-central part of the country, with values ranging from about −1.5° C. to −3.4° C. In addition, a secondary region of rather pronounced negative departures at the surface occurred in a strip nearly 150 miles wide extending from the vicinity of western Tennessee northeastward to about Burlington, Vt., with a lower extreme departure of nearly −3.0° C. The largest positive departures were principally confined to the northwestern border states with values ranging from +0.5° C. to +2.5° C. Elsewhere the departures were generally within the range ±1.5° C.

The mean free-air temperatures for the month up to 5 km above sea level (table 1) were generally below normal over the country except the extreme northwestern section and the Florida Peninsula and vicinity, where they were above normal. In harmony with the conditions at the surface, the most pronounced negative departures from normal were principally confined to an elliptical area extending (lengthwise) from the south-central to the northeastern portion of the country, with the major axis roughly thrice the minor axis. The departures in this area ranged approximately from −1.5° C. to −5.5° C. (Oklahoma City at 1 km), with departures slightly more pronounced over the northeastern than over the northwestern sector above 2 km. In the extreme southwest, significantly subnormal free-air temperatures also occurred as exemplified by departures from −0.6° C. to −2.9° C. (at 2 km) over San Diego, Calif. The most pronounced positive departures occurred over the general area comprising the Northwestern States from Washington to Montana, with values ranging as high as +4.2° C. (Spokane at 5 km). Elsewhere over the country, the departures from normal temperature were not very marked.

The mean free-air relative humidities and specific humidities are given in table 2. The mean relative humidities were moderately above normal in the Southwest, with maximum departures occurring at San Diego where they ranged from +4 to +13 percent. Over the central part of the country the departures were also generally positive by moderate amounts below 2 km, while above that elevation they were only slightly in excess of normal. Over the northern third of the country only slight positive departures from normal relative humidity generally prevailed, with maxima occurring near Billings and Boston, particularly in the lower strata (+10 percent at surface, falling to +6 percent at 1 km, over the former station; and +5 to +9 percent from 1 to 3 km, over the latter). Over the southeast, slight to moderate negative departures generally prevailed, except near the surface along the Gulf coast where the opposite was true. The extreme departures in this area occurred in the vicinity of Murfreesboro, Tenn., where the deficiencies with respect to normal ranged between −2 percent and

−11 percent from 1.5 to 5 km. Over other areas the departures from normal were generally not appreciable in amount.

Table 3 shows the monthly mean free-air barometric pressures and equivalent potential temperatures. The lowest mean barometric pressures prevailed over the northeastern part of the country, with the minima located near Boston in the stratum up to 1.5 km, and between that place and Sault Ste. Marie, but nearer the latter, at higher elevations, so far as available observations indicate. The statistical center of lowest mean pressure was thus displaced farther eastward with respect to its positions during the preceding 2 months. A secondary center of low pressure of considerably lesser intensity than the foregoing was in evidence in the lower strata over the extreme northwestern corner of the country. The highest mean barometric pressures in the free air over the country up to 5 km had their loci in the coastal strip contiguous to the Gulf of Mexico, displaced, however, in the lowest km more toward the western Gulf. The mean free-air isobars over the central and southern portions of the Western Plateau were characterized by a northward displacement with respect to their positions along the western and eastern boundaries of this elevated region, thus indicating by their anticyclonic curl the presence of weak statistical center of high pressure over the southern portion.

The mean isobaric charts for March, in marked contrast to those for the preceding 2 months, thus showed marked cyclonic curvature over the northeast in the lower strata with conditions apparently favorable there for the transport of air from the northwest and north into the eastern half of the country. The anticyclonic curvature of isobars over the Western Plateau and Gulf regions with practically straight west-east isobars in the upper strata over the eastern portion of the country were favorable for the transport of air from the Pacific toward the Western Plateau principally from a southwesterly direction, subsequently recurving so as to come from westerly and northwesterly directions in its trajectory across the plateau and the lower terrain to the east.

On the assumption that differences between the mean monthly barometric pressures given for the various pairs of stations are closely representative of the mean pressure gradients between the respective pairs of stations during the month, the data indicate that the mean pressure gradients from San Antonio to Oakland at levels up to 5 km remained practically the same in March as they had been in February. However, the gradients from Oakland to Fargo decreased by 113 percent at 1 km from February to March, i. e., the gradient reversed; and at higher levels decreased from 80 percent at 1.5 km to 37 percent at 5 km. On the other hand, the gradients from Billings to Sault Ste. Marie increased approximately 60 to 70 percent between the 2 months, while from Omaha to Boston where the mean gradients were practically nil in February the gradients during March were nearly as large as those which existed between the two stations just previously referred to. The gradients from Miami to Sault Ste. Marie decreased 33 percent at 1 km diminishing to 9 percent at 5 km, between the respective months.

Table 4 shows the free-air resultant winds based on pilot-balloon observations made near 5 a. m. (75th meridian time) during March. The resultant winds along the West coast near Oakland, while not greatly different from normal in velocity, were oriented from 50° to 90° counterclockwise from normal, i. e. more from the west and southwest than northwest. Similar conditions prevailed near Medford, Oreg., at elevations from 3 to 4 km, but free-air resultant winds below that stratum were approximately normal. Over Seattle, and Spokane, the resultant winds were oriented from 40° to 90° counterclockwise from normal, hence more from the south than west as usual, with velocities in excess of normal by 1 to 4 m. p. s. in the case of the former station, but deficient with respect to normal by 0.5 to 6.1 m. p. s. in the latter case. Near San Diego practically normal resultant winds prevailed. The resultant winds in the free air over Salt Lake City were oriented with respect to normal by about one-half the amounts specified for Seattle, with slightly deficient velocities.

In general, the resultant wind directions over the balance of the country were practically normal, except in the lowest kilometer above sea level between the Mississippi River and the Appalachian Mountains, where in many cases the resultants were oriented from 45° to 90° clockwise from normal, hence more from NW. than SW. and W. The resultant velocities over the balance of the country were generally deficient with respect to normal by several meters per second, except over the northeast sector where they were in excess of normal from 1.5 to 5.8 m. p. s. Over Billings, Cheyenne, Oklahoma City, and Pensacola, deficiencies of about 3 to 5 m. p. s., in resultant velocities occurred from 2.5 to 4 km, while over Houston excesses of about 0.9 to 5.9 m. p. s. occurred in the same stratum.

Table 5 shows maximum free-air wind velocities and directions for various sections of the United States during March as determined by pilot balloon observations. The extreme maximum was 59.0 m. p. s. from the NW at 6,840 meters above sea level over Greensboro, N. C.

The mean monthly equivalent potential temperatures and specific humidities are shown in tables 2 and 3, respectively. The geographic distributions of these elements indicate general conformity with the air trajectories inferred from the mean isobaric charts for the month. The relatively high values over Salt Lake City with respect to surrounding stations in the stratum from about 2 to somewhat over 4 km are especially noteworthy as indicative of the mean anticyclonic curl of the air motion above the Western Plateau already mentioned above.

Considerable contrast existed during March in the weather over the western and the eastern halves of the country. The eastern half was frequently dominated by extensive anticyclones, formed by the spreading out over this area of relatively cold Pc or Npc air masses from central and western Canada, overlain by strata of Pp or Npp origin, or mixed with them. This situation to a great extent prevented the transport of warm, moist Ta air masses from the Gulf of Mexico up the eastern portion of the Mississippi Valley. These factors contributed greatly to the subnormal temperatures and deficient precipitation generally experienced in the area under consideration; the charts given in the Weekly Weather and Crop Bulletin for the week ending April 6, 1937, indicate that only 25 to 75 percent of normal precipitation was observed there.

On the other hand, the Pacific coastal region was visited by an abnormally large number of cyclones from the ocean to the west and north, principally in an occluded state. The Npp and occasionally Tp air masses in the troughs of these cyclones, on being forced to ascend the Pp wedges of air, gave rise to strong development of the distrubances with the production of an abundance of precipitation over a large part of the Western Plateau region, from 150 to 250 percent of normal, except over parts of Utah, Colorado, and New Mexico; in the latter area precipitation was about 50 to 100 percent of normal. The advance of the Npp and Tp air masses eastward led to their interaction with the

considerably colder Pc air masses in the vicinity of the eastern flanks of the plateau, thus leading to excessive precipitation, from 150 to 200 percent of normal, in that area. The anticyclonic circulation along the southwestern peripheries of the HIGHS which frequently lay over the southeastern part of the country did allow some TA air to move northward and westward across Texas and adjoining territory, in this way contributing in a fairly important degree to the precipitation which occurred over the western Great Plains by furnishing fresh moisture supplies for the occluding cyclones advancing eastward from the Pacific Southwest.

A few active cyclones formed in the western Gulf of Mexico and moved counterclockwise around the peripheries of the cold air masses extending over the southeastern part of the country. These gave a superabundance of rainfall in Florida, and contributed to the precipitation which occurred along the eastern coastal region as they advanced northward. On reaching the vicinity of the Gulf of St. Lawrence and Labrador, a majority of them had an extraordinary development and in some cases moved somewhat westward toward Hudson Bay. The strong cyclonic circulation about these storms caused the transportation of relatively cold, dry PA air into the northeastern part of the country, especially at moderate elevations above the ground. This was an important factor underlying the very deficient precipitation near the western Great Lakes and adjoining regions.

TABLE 1.—*Mean free-air temperatures (t), °C. obtained by airplanes during March 1937. (Dep. represents departure from "normal" temperature)*

Stations	Altitude (meters) m. s. l.																		
	Surface			500		1,000		1,500		2,000		2,500		3,000		4,000		5,000	
	Number of obs.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.
Barksdale Field [1] (Shreveport), La. (52 m)	31	9.0		8.3		7.0		6.4		4.5		2.3		0.0		−6.6			
Billings, Mont.[2] (1,089 m)	28	−1.7	+0.2					0.3	+0.8	−1.3	+1.3	−3.6	+2.2	−6.4	+2.7	−12.3	+3.2	−18.8	+3.4
Boston, Mass.[1] (5 m)	30	−1.9	−2.2	−3.4	−1.2	−5.9	−1.8	−7.6	−2.2	−8.8	−2.1	−10.5	−1.9	−12.4	−1.9	−17.3	−1.7		
Cheyenne, Wyo.[2] (1,873 m)	29	−3.5	−0.8							−2.6	−0.6	−4.4	−1.3	−7.1	−1.3	−13.4	−1.1	−20.7	−1.3
Coco Solo, Canal Zone [3] (15 m)	29	25.0		22.7		20.6		18.3		16.4		15.5		13.7		8.0		2.8	
El Paso, Tex.[2] (1,194 m)	31	7.2						9.3		7.3		4.7		1.3		−5.2		−11.3	
Fargo, N. Dak.[2] (274 m)	31	−6.7	−1.0	−5.3	−0.5	−6.6	−1.2	−7.4	−1.0	−9.0	−1.0	−11.1	−1.1	−13.1	−0.6	−18.1	0.0	−24.7	+0.4
Kelly Field (San Antonio), Tex.[1] (206 m)	25	8.4	−3.5	10.1	−4.0	9.5	−3.8	8.8	−3.4	8.0	−2.6	5.6	−2.8	3.7	−2.0	−2.4	−1.4	−9.3	−1.1
Lakehurst, N. J.[3] (39 m)	24	−0.7	−3.4	−1.5	−4.4	−3.9	−5.0	−5.0	−4.7	−6.0	−4.0	−8.1	−3.8	−10.5	−3.7	−15.4	−2.7	−21.2	−1.5
Maxwell Field (Montgomery), Ala.[1] (52 m)	22	9.8	−1.4	9.8	−2.6	7.9	−2.7	6.8	−1.6	5.3	−1.2	3.5	−0.7	0.7	−0.9	−5.1	−0.3	−11.6	−0.4
Miami, Fla.[2] (4 m)	31	16.8		18.0		14.9		12.6		10.8		8.7		6.4		1.1		−4.2	
Mitchel Field (Hempstead, L. I.), N. Y.[1] (29 m)	28	−0.8	−3.0	−1.6	−4.3	−3.4	−4.5	−5.1	−4.4	−6.0	−3.9	−7.8	−3.5	−9.9	−3.2	−14.1	−2.1		
Murfreesboro, Tenn.[2] (174 m)	31	4.3	−3.1	4.8	−3.9	2.5	−4.5	1.5	−3.9	−0.4	−3.5	−1.7	−2.8	−3.9	−2.3	−9.3	−1.6	−15.8	−1.7
Norfolk, Va.[3] (10 m)	21	4.2	−2.7	4.0	−2.6	1.2	−3.4	−0.4	−2.8	−2.2	−2.5	−4.6	−2.9	−7.0	−3.2	−12.5	−2.8	−17.1	−1.9
Oakland, Calif.[2] (2 m)	31	10.0		9.6		7.2		4.5		1.6		−0.9		−3.5		−9.8		−16.5	
Oklahoma City, Okla.[2] (391 m)	31	4.1	−4.1	4.8	−4.3	3.8	−5.5	3.0	−4.8	1.9	−3.8	0.1	−3.0	−2.1	−2.4	−8.7	−2.0	−15.3	−1.7
Omaha, Nebr.[2] (300 m)	31	−0.4	−0.2	0.2	−0.3	−0.5	−1.3	−2.6	−2.5	−4.4	−2.8	−5.8	−1.9	−7.8	−1.2	−13.3	−0.3	−19.6	+0.1
Pensacola, Fla.[3] (13 m)	27	10.0	−1.4	10.7	−0.3	9.7	+0.4	8.6	+1.0	6.9	+1.3	4.6	+1.2	2.1	+0.9	−3.4	+0.8	−8.4	+2.1
St. Thomas, Virgin Islands [3] (8 m)	31	23.0		20.7		17.8		14.8		12.2		10.9		9.8		5.1		−0.3	
Salt Lake City, Utah [2] (1,288 m)	31	1.7						4.3		2.5		−0.5		−3.6		−10.0		−16.0	
San Diego, Calif.[3] (10 m)	31	10.6	−3.3	11.4	−1.5	9.8	−2.3	7.3	−2.7	4.7	−2.9	2.2	−2.6	−0.5	−2.4	−5.9	−1.1	−11.8	−0.6
Sault Ste. Marie, Mich.[2] (221 m)	31	−7.6		−7.6		−9.3		−11.4		−12.5		−13.6		−15.7		−21.3		−27.5	
Scott Field (Belleville), Ill.[1] (135 m)	19	0.0	−3.9	2.8	−3.3	0.9	−4.6	−0.5	−3.4	−2.2	−4.1	−4.0	−3.4	−6.1	−3.0	−10.9	−2.1	−17.6	−2.5
Seattle, Wash.[2] (10 m)	12	9.8		7.7		5.4		2.0		−1.2		−4.5		−7.7		−14.3			
Selfridge Field (Mount Clemens), Mich.[1] (177 m)	28	−3.4		−3.7		−6.1		−7.7		−9.1		−11.0		−13.5		−18.2		−23.4	
Spokane, Wash.[2] (596 m)	31	1.9	+0.4			5.0	+2.6	3.1	+2.8	0.1	+3.1	−3.0	+3.1	−6.3	+3.2	−12.4	+3.7	−18.6	+4.2
Washington, D. C.[2] (13 m)	27	2.6	−1.2	2.1	−1.2	−0.3	−1.8	−2.2	−1.7	−3.6	−1.3	−5.5	−1.3	−8.0	−1.7	−13.2	−1.3	−19.4	−1.4
Wright Field (Dayton), Ohio [1] (244 m)	28	−1.4	−4.0	−0.7	−3.8	−1.8	−4.6	−3.7	−4.7	−5.3	−4.5	−7.2	−4.3	−9.4	−4.1	−14.2	−3.3	−20.4	−2.8

[1] Army.
[2] Weather Bureau.
[3] Navy.

Observations taken about 4 a. m., 75th meridian time, except by Navy stations along the Pacific coast and Hawaii where they are taken at dawn.

NOTE.—The departures are based on normals covering the following total number of observations made during the same month in previous years, including the current month (years of record are given in parentheses following the number of observations): Billings, 87 (3); Boston, 100 (4); Cheyenne, 88 (3); Fargo, 91 (3); Kelly Field, 84 (3); Lakehurst, 68 (3); Maxwell Field, 73 (3); Mitchel Field, 79 (3); Murfreesboro, 93 (3); Norfolk, 154 (8); Oklahoma City, 87 (3); Omaha, 185 (6); Pensacola, 153 (7); San Diego, 213 (9); Scott Field, (75) 3; Spokane, 92 (3); Washington, 154 (8); Wright Field, 84 (3).

TABLE 2.—*Mean free-air relative humidities (R. H.), in percent, and specific humidities (q), in grams/kilogram, obtained by airplanes during March 1937 (Dep. represents departure from "normal" relative humidity)*

Station	Number of observations	Surface q	Surface R. H. Mean	Surface R. H. Dep.	500 q	500 R. H. Mean	500 R. H. Dep.	1,000 q	1,000 R. H. Mean	1,000 R. H. Dep.	1,500 q	1,500 R. H. Mean	1,500 R. H. Dep.	2,000 q	2,000 R. H. Mean	2,000 R. H. Dep.	2,500 q	2,500 R. H. Mean	2,500 R. H. Dep.	3,000 q	3,000 R. H. Mean	3,000 R. H. Dep.	4,000 q	4,000 R. H. Mean	4,000 R. H. Dep.	5,000 q	5,000 R. H. Mean	5,000 R. H. Dep.
Barksdale Field, La	31	5.6	78		4.7	65		4.3	61		3.8	53		3.3	50		2.7	44		2.2	41		1.4	35				
Billings, Mont	28	3.0	79	+10							3.2	68	+8	2.9	64	+6	2.5	61	+2	2.1	61	0	1.3	56	−3	0.8	51	−3
Boston, Mass	30	2.3	70	+2	2.3	70	+2	2.0	72	+6	1.8	72	+9	1.7	66	+6	1.5	64	+5	1.2	61	+5	0.9	55	+3			
Cheyenne, Wyo	29	2.7	72	+9										2.8	69	+7	2.4	65	+7	2.1	63	+7	1.3	58	+3	0.7	56	+4
Coco Solo, Canal Zone	29	17.5	86		17.2	92		15.1	87		12.9	81		11.7	78		7.8	52		5.0	35		3.8	35		2.6	30	
El Paso, Tex	31	3.6	49								4.0	45		3.7	46		3.3	47		3.0	49		1.8	44		1.0	34	
Fargo, N. Dak	31	2.0	83	0	2.0	75	−2	1.7	68	0	1.7	64	+1	1.5	61	+1	1.3	61	+2	1.2	60	+4	0.9	58	+5	0.6	58	+6
Kelly Field, Tex	25	5.6	80	−2	5.7	70	−3	5.1	62	−3	4.6	55	−3	4.4	52	−2	4.0	52	+4	3.3	47	+3	2.4	46	+4	1.7	48	+7
Lakehurst, N. J	24	2.6	70	−5	2.2	59	−4	2.0	61	+1	1.8	59	+1	1.8	55	+2	1.7	57	+4	1.6	58	+6	0.8	49	+2	0.6	55	+9
Maxwell Field, Ala	22	5.4	72	−3	4.7	59	−1	3.7	50	−2	3.5	47	−1	2.9	41	0	2.3	37	+2	2.0	36	+3	1.2	32	+2	0.8	28	−2
Miami, Fla	31	10.8	92		10.2	75		8.7	74		7.0	65		5.6	56		4.6	50		3.9	47		3.1	48		2.4	46	
Mitchel Field, N. Y	28	2.4	68	−9	2.4	67	−2	2.2	65	−1	1.9	63	0	1.8	56	−1	1.7	55	−1	1.5	54	−1	1.3	59	+4			
Murfreesboro, Tenn	31	4.2	81	0	3.9	70	0	3.4	67	0	3.0	59	−2	2.1	47	−8	2.0	46	−5	1.9	45	−5	1.1	37	−7	0.6	31	−11
Norfolk, Va	21	3.4	68	−1	2.9	54	−6	2.6	56	−2	2.2	51	−5	1.9	48	−5	1.6	46	−3	1.4	43	−2	0.8	37	−6	0.6	37	−6
Oakland, Calif	31	6.7	88		6.0	76		5.0	70		4.0	65		3.3	62		2.8	58		2.3	56		1.6	53		0.9	48	
Oklahoma City, Okla	31	4.1	77	+8	4.1	73	+7	3.8	68	+11	3.3	60	+9	2.8	52	+6	2.2	44	+3	2.0	42	+2	1.4	43	+2	0.9	44	+3
Omaha, Nebr	31	3.4	87	+9	3.3	80	+7	2.9	71	+9	2.7	71	+14	2.2	61	+9	1.8	54	+3	1.6	54	+2	1.2	54	+2	0.8	55	+3
Pensacola, Fla	27	6.6	86	+7	6.2	74	+5	5.4	64	+3	4.4	53	−2	3.5	44	−6	3.1	45	−3	2.6	41	−4	1.9	39	−3	1.3	36	−5
St. Thomas, Virgin Islands	31	14.8	85		14.0	87		12.1	86		9.9	80		7.7	69		5.4	48		3.4	31		1.8	19		1.0	15	
Salt Lake City, Utah	31	3.9	78								4.1	67		3.7	64		3.2	65		2.8	68		2.1	71		1.2	61	
San Diego, Calif	31	6.8	85	+11	6.6	74	+4	5.4	65	+9	4.3	58	+11	3.5	52	+13	2.7	45	+12	2.2	41	+11	1.3	36	+9	0.9	34	+7
Sault Ste. Marie, Mich	31	1.7	77		1.8	74		1.5	70		1.3	68		1.2	63		1.0	58		0.9	57		0.8	59		0.4	54	
Scott Field, Ill	19	3.0	81	+2	3.1	66	+1	2.7	59	+3	2.2	51	+1	1.9	47	0	1.7	43	−1	1.6	43	−1	1.1	42	+1	0.8	43	−1
Seattle, Wash	12	5.7	77		4.7	71		4.1	68		3.4	66		2.9	67		2.5	68		2.1	67		1.3	64				
Selfridge Field, Mich	28	2.3	76		2.2	72		1.9	69		1.7	63		1.4	58		1.3	57		1.1	55		0.7	50		0.5	49	
Spokane, Wash	31	3.7	79	+3				4.0	65	−2	3.6	63	−1	3.3	65	+1	2.7	65	+2	2.3	65	+1	1.4	60	−1	0.9	56	−3
Washington, D. C	27	3.4	73	+3	2.8	62	−1	2.6	61	+1	2.4	61	+2	2.1	58	+1	1.9	55	+2	1.6	53	+2	1.1	50	+1	0.7	43	−2
Wright Field, Ohio	28	2.9	83	+4	2.9	76	+2	2.7	72	+5	2.3	66	+4	1.9	57	0.0	1.5	52	−1	1.3	50	0.0	1.0	48	+1	0.7	49	+1

TABLE 3.—*Mean free-air barometric pressures (P), in mb, and equivalent potential temperatures (θ_e), in °A. obtained by airplanes during March 1937*

Stations	Number of observations	Surface P	Surface θ_e	500 P	500 θ_e	1,000 P	1,000 θ_e	1,500 P	1,500 θ_e	2,000 P	2,000 θ_e	2,500 P	2,500 θ_e	3,000 P	3,000 θ_e	4,000 P	4,000 θ_e	5,000 P	5,000 θ_e
Barksdale Field, La	31	1,013	297	960	298	904	301	850	304	800	306	751	307	706	309	622	310		
Billings, Mont	28	893	289					848	296	797	299	748	300	702	302	616	304	540	306
Boston, Mass	30	1,011	277	950	280	892	381	837	285	785	288	736	291	689	294	604	299		
Cheyenne, Wyo	29	809	294							796	297	747	300	701	301	615	303	538	304
Coco Solo, Canal Zone	29	1,009	350	952	352	899	349	848	346	800	346	753	339	710	334	630	334	558	336
El Paso, Tex	31	881	301					848	308	799	310	752	312	706	311	624	313	549	314
Fargo, N. Dak	31	988	273	961	276	902	280	846	284	793	287	744	290	696	292	610	297	532	300
Kelly Field, Tex	25	995	297	963	302	906	305	853	308	803	312	755	314	711	315	628	317	554	318
Lakehurst, N. J	24	1,010	279	953	281	895	284	838	287	788	291	739	294	694	297	608	300	534	304
Maxwell Field, Ala	22	1,011	297	958	300	902	300	848	304	798	306	751	308	706	309	622	310	548	314
Miami, Fla	31	1,016	318	959	324	905	321	853	320	804	319	756	320	712	320	630	323	556	326
Mitchel Field, N. Y	28	1,011	278	953	282	895	285	840	287	788	291	739	294	693	298	609	303		
Murfreesboro, Tenn	31	997	289	958	292	901	293	847	297	796	298	748	302	702	304	618	306	542	309
Norfolk, Va	21	1,015	286	956	289	898	290	844	293	793	296	744	297	699	299	613	302	530	308
Oakland, Calif	31	1,016	300	957	303	901	303	848	303	797	304	749	304	704	305	619	308	544	309
Oklahoma City, Okla	31	972	291	960	293	902	296	848	299	797	302	749	304	704	306	620	308	544	310
Omaha, Nebr	31	984	283	959	286	901	289	846	292	794	294	745	296	699	299	613	303	538	306
Pensacola, Fla	27	1,020	300	962	304	906	306	853	308	803	309	755	311	709	312	626	315	552	318
St. Thomas, Virgin Islands	31	1,015	337	960	337	905	334	853	330	804	327	757	324	713	323	632	324	559	326
Salt Lake City, Utah	31	870	297					848	302	798	305	750	306	704	307	620	308	545	310
San Diego, Calif	31	1,015	301	957	307	901	307	848	307	798	307	750	308	705	309	622	311	547	314
Sault Ste. Marie, Mich	31	990	271	955	274	895	277	838	279	785	282	735	287	688	289	602	294	525	297
Scott Field, Ill	19	1,005	281	962	287	903	290	849	292	797	295	748	298	702	300	616	305	540	308
Seattle, Wash	12	1,014	297	956	297	899	299	844	298	793	299	745	300	699	301	613	302		
Selfridge Field, Mich	28	996	276	956	279	898	281	843	284	791	287	741	290	694	292	608	296	532	301
Spokane, Wash	31	945	290			900	298	846	300	795	302	746	303	701	303	615	304	540	307
Washington, D. C	27	1,017	284	955	287	898	289	843	291	792	294	743	297	697	299	611	303	536	306
Wright Field, Ohio	28	989	280	957	284	899	287	845	289	793	292	744	294	698	297	612	301	537	305

TABLE 4.—*Free-air resultant winds (meters per second) based on pilot-balloon observations made near 5 a. m. (E. S. T.) during March 1937*

[Wind from N=360°, E=90°, etc.]

Altitude (meters) m. s. l.	Albuquerque, N. Mex. (1,554 m)		Atlanta, Ga. (309 m)		Billings, Mont. (1,088 m)		Boston, Mass. (15 m)		Cheyenne, Wyo. (1,873 m)		Chicago, Ill. (192 m)		Cincinnati, Ohio (153 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°	
Surface	345	0.1	312	3.0	328	1.6	304	3.1	286	4.9	321	2.0	327	1.2
500			309	4.8			304	9.4			323	4.4	325	2.4
1,000			308	5.8			303	9.6			332	5.1	307	4.8
1,500			287	6.6	263	2.6	299	10.7			308	8.2	299	6.5
2,000	307	1.8	282	7.5	276	2.6	297	12.1	290	6.7	303	10.5	297	8.0
2,500	291	3.7	296	8.8	303	4.0	294	14.0	298	8.5	295	12.8	311	7.4
3,000	288	5.9	284	10.5	295	5.9	292	16.3	311	7.6				
4,000	269	7.8			291	7.0			299	7.1				
5,000	261	8.7												

Altitude (meters) m. s. l.	Detroit, Mich. 204 m)		Fargo, N. Dak. (274 m)		Houston, Tex. (21 m)		Key West, Fla. (11 m)		Medford, Oreg. (410 m)		[1]Murfreesboro, Tenn. (180 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°	
Surface	294	2.5	5	1.0	42	2.2	66	2.2	341	0.4	324	1.1
500	311	6.1	308	1.5	100	3.8	93	4.0	312	0.4	341	2.8
1,000	310	7.7	325	3.2	145	1.2	138	2.7	178	1.8	299	4.5
1,500	301	9.0	304	4.6	255	2.7	211	1.4	193	3.9	272	5.5
2,000	305	11.2	308	7.7	275	4.5	244	2.5	209	6.1	295	6.8
2,500	305	12.6	308	9.9	269	6.5	260	3.4	226	5.6	302	8.5
3,000	293	11.2	300	10.1	275	9.0	275	4.4	210	4.3	306	9.7
4,000					280	12.7	282	6.0	239	9.4		
5,000												

Altitude (meters) m. s. l.	Newark, N. J. (14 m)		Oakland, Calif. (8 m)		Oklahoma City, Okla. (402 m)		Omaha, Nebr. (306 m)		Pearl Harbor, Territory of Hawaii [1] (68m)		Pensacola, Fla.[1] (24 m)		St. Louis, Mo. (170 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°	
Surface	284	3.3	231	0.6	27	0.9	30	1.1	36	3.2	11	3.9	308	1.3
500	299	6.4	253	1.8	172	1.8	321	1.2	69	5.1	38	2.7	307	2.8
1,000	309	8.8	274	1.3	238	4.1	292	2.8	92	4.7	293	2.1	305	3.5
1,500	301	11.0	252	2.0	259	2.9	301	4.2	112	3.1	271	6.1	297	5.4
2,000	288	11.7	250	2.0	298	4.7	306	7.1	168	2.7	284	6.2	288	6.4
2,500	296	17.6	222	3.9	293	4.7	305	8.5	216	3.0	295	4.9	293	7.5
3,000			224	5.0	285	4.3	312	11.6	223	4.4	290	7.2	289	7.9
4,000					299	8.0	316	10.5	320	2.4	285	8.7	289	7.9
5,000														

Altitude (meters) m. s. l.	Salt Lake City, Utah (1,294 m)		San Diego, Calif. (15 m)		Sault Ste. Marie, Mich. (198 m)		Seattle, Wash. (14 m)		Spokane, Wash. (603 m)		Washington, D. C. (10 m)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°	
Surface	151	2.5	38	0.5	340	1.4	128	0.6	88	1.9	310	2.1
500			271	2.2	356	3.7	153	2.6			301	7.8
1,000			274	2.9	338	5.6	162	4.8	115	3.0	304	9.4
1,500	158	3.6	275	3.1	325	6.3	169	4.6	178	2.4	302	11.0
2,000	182	3.7	295	4.0	318	9.1	163	4.2	199	2.8	288	11.6
2,500	221	3.0	303	5.4	314	10.6	172	6.2	213	3.7	279	12.2
3,000	249	3.5	289	6.1	296	8.9	186	7.1	233	4.4		
4,000	263	5.0	290	6.9	271	4.4			238	2.8		
5,000	275	6.1										

[1] Navy stations.

TABLE 5.—*Maximum free-air wind velocities (M. P. S.) for different sections of the United States based on pilot balloon observations during March 1937*

Section	Surface to 2,500 meters (m. s. l.)					Between 2,500 and 5,000 meters (m. s. l.)					Above 5,000 meters (m. s. l.)				
	Maximum velocity	Direction	Altitude (m) M. S. L.	Date	Station	Maximum velocity	Direction	Altitude (m) M. S. L.	Date	Station	Maximum velocity	Direction	Altitude (m) M. S. L.	Date	Station
Northeast [1]	40.1	NW	2,500	7	Albany, N. Y	49.2	NNW	3,600	7	Albany, N. Y	27.4	W	5,760	31	Albany, N. Y.
East-Central [2]	32.8	NNW	1,540	28	Washington, D. C	49.0	WNW	4,060	17	Washington, D. C	59.0	NW	6,840	5	Greensboro, N. C.
Southeast [3]	27.1	WSW	2,440	8	Jacksonville, Fla	42.6	W	4,960	28	Jacksonville, Fla	42.6	W	5,050	28	Jacksonville, Fla.
North-Central [4]	30.0	NNW	2,470	8	St. Paul, Minn	40.8	W	4,970	22	Detroit, Mich	41.6	WNW	5,950	22	Fargo, N. Dak.
Central [5]	29.1	NW	2,380	8	Omaha, Nebr	36.8	NW	3,820	9	Omaha, Nebr	41.2	WNW	6,100	21	Indianapolis, Ind.
South-Central [6]	34.0	W	1,200	24	Oklahoma City, Okla	32.0	W	4,360	6	Del Rio, Tex	35.0	W	8,160	20	Dallas, Tex.
Northwest [7]	30.7	SE	1,650	21	Boise, Idaho	33.6	SW	4,010	23	Medford, Oreg	38.0	WNW	10,990	7	Missoula, Mont.
West-Central [8]	31.3	NW	2,480	23	Cheyenne, Wyo	38.2	SSW	4,090	22	Modena, Utah	56.4	WNW	7,870	18	Redding, Calif.
Southwest [9]	26.5	WSW	1,900	23	Winslow, Ariz	37.0	NNE	4,800	3	Las Vegas, Nev	51.4	WSW	6,060	25	Winslow, Ariz.

[1] Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and northern Ohio.
[2] Delaware, Maryland, Virginia, West Virginia, southern Ohio, Kentucky, eastern Tennessee, and North Carolina.
[3] South Carolina, Georgia, Florida, and Alabama.
[4] Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.
[5] Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.
[6] Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except El Paso), and western Tennessee.
[7] Montana, Idaho, Washington, and Oregon.
[8] Wyoming, Colorado, Utah, northern Nevada, and northern California.
[9] Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.

LATE REPORT

TABLE 1.—*Mean free-air temperatures (t), °C obtained by airplanes during February, 1937. (Dep. represents departure from "normal" temperature)*

Stations	Number of observations	Altitude (meters) m. s. l.																	
		Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000	
		t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.
Pearl Harbor, Territory of Hawaii [1] (6 m)	26	19.2	−1.3	18.2	−0.8	14.9	−0.4	11.9	−0.4	9.5	+0.8	7.5	−0.2	5.5	−0.5	0.6	+0.1	−5.2	+1.1

[1] Navy.

Observations taken at dawn.

NOTE.—The departures are based on normals covering the following total number of observations made during the same month in previous years, including the current month (years of record are given in parentheses following the number of observations): Pearl Harbor, 115 (5).

LATE REPORT

TABLE 2.—*Mean free-air relative humidities (R. H.), in percent, and specific humitidies (q), in grams/kilogram, obtained by airplanes during February 1937. (Dep. represents departure from "normal" relative humidity)*

Station	Number of observations	Surface			500			1,000			1,500			2,000			2,500			3,000			4,000			5,000		
		q	R. H. Mean	R. H. Dep.	q	R. H. Mean	R. H. Dep.	q	R. H. Mean	R. H. Dep.	q	R. H. Mean	R. H. Dep.	q	R. H. Mean	R. H. Dep.	q	R. H. Mean	R. H. Dep.	q	R. H. Mean	R. H. Dep.	q	R. H. Mean	R. H. Dep.	q	R. H. Mean	R. H. Dep.
Pearl Harbor, Territory of Hawaii	26	11.8	86	+8	10.7	78	+3	9.6	82	+5	8.7	85	+12	7.3	79	+23	5.2	62	+18	4.2	53	+19	2.0	32	+12	1.2	29	+9

Altitude (meters) m. s. l.

LATE REPORT

TABLE 3.—*Mean free-air barometric pressures (P), in mb, and equivalent potential temperatures (Θ_E), in °A. obtained by airplanes during February 1937*

Station	Number of observations	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000	
		P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E
Pearl Harbor, Territory of Hawaii	26	1,016	324	959	325	904	324	852	324	802	322	755	320	710	320	628	319	553	322

Altitude (meters) m. s. l.

LATE REPORT

TABLE 1.—*Mean free-air temperatures (t), °C obtained by airplanes during January 1937. (Dep. represents departure from "normal" temperature.)*

Station	Number of observations	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000	
		t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.	t	Dep.
Pearl Harbor, Territory of Hawaii [1] (6 m)	31	19.3	−1.3	19.2	0.0	15.9	+0.5	13.1	+0.6	10.9	+0.3	8.7	+0.1	5.9	0.0	0.8	+0.1	−5.6	−0.1

Altitude (meters) m. s. l.

[1] Navy.

Observations taken at dawn.

NOTE.—The departures are based on normals covering the following total number of observations made during the same month in previous years, including the current month (years of record are given in parentheses following the number of observations): Pearl Harbor, 117 (4).

LATE REPORT

TABLE 2.—*Mean free-air relative humidities (R. H.), in percent, and specific humidities (q), in grams/kilogram, obtained by airplanes during January 1937. (Dep. represents departure from "normal" relative humidity)*

Station	Number of observations	Surface			500			1,000			1,500			2,000			2,500			3,000			4,000			5,000		
		q	R. H. Mean	R. H. Dep.	q	R. H. Mean	R. H. Dep.	q	R. H. Mean	R. H. Dep.	q	R. H. Mean	R. H. Dep.	q	R. H. Mean	R. H. Dep.	q	R. H. Mean	R. H. Dep.	q	R. H. Mean	R. H. Dep.	q	R. H. Mean	R. H. Dep.	q	R. H. Mean	R. H. Dep.
Pearl Harbor, Territory of Hawaii	31	12.0	87	+8	811.2	77	+2	10.1	80	+2	8.4	76	+3	6.4	64	+5	5.0	54	+6	3.9	40	+8	2.3	35	+6	1.8	37	+10

Altitude (meters) m. s. l.

LATE REPORT

TABLE 3.—*Mean free-air barometric pressures (P), in mb, and equivalent potential temperatures (Θ_E), in °A. obtained by airplanes during January 1937*

Station	Number of observations	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000	
		P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E	P	Θ_E
Pearl Harbor, Territory of Hawaii	31	1,013	324	957	328	902	327	851	324	802	322	755	320	710	320	628	321	553	323

Altitude (meters) m. s. l.

RIVERS AND FLOODS

[River and Flood Division, MERRILL BERNARD in charge]

By BENNETT SWENSON

Atlantic slope drainage.—Light flooding continued from January and February into March in most of the rivers from South Carolina southward. Continued rain and slow run-off over the Santee Basin in South Carolina resulted in stages near or slightly above flood stage during the entire month.

Rains on the 15th and again on the 20th caused further rises in the Savannah and Altamaha systems in South Carolina and Georgia. Flood stage was only slightly exceeded at a few points on these rivers.

No damage of consequence resulted from the flooding in this region.

East Gulf of Mexico drainage.—Most of the rivers in this area continued slightly above flood stage from the previous month. No further losses were reported as a result of this continuation of high water.

Moderately heavy to heavy rains occurred on the 19th and 20th and again on the 24th and 25th over most of the drainage area. As a result of these rains minor floods occurred in the Apalachicola, Alabama, Tombigbee, and Pear rivers during the latter part of March. As these floods followed higher stages during January and February no further losses of consequence were incurred.

Upper Mississippi drainage.—High temperatures prevailed during the first week of March in this region. Thawing resulted in the streams in Iowa, and northern Illinois that were already swollen and choked with ice following the floods of the latter part of February and flooding again resulted in these streams. The Mississippi River went slightly above flood stage from Keithsburg, Ill., to Grafton, Ill., on March 7 to 17.

Considerable damage resulted at some points from these floods during February and March but reports of all the losses are not available at this time. The losses from the sudden floods which occurred during February in the southern and eastern portions of Wisconsin are estimated at about $200,000. A gorge formed at the mouth of the Skunk River in Iowa in February and resulted in the flooding of about 10,000 acres of lowland south of Burlington, Iowa, but no great amount of damage occurred. The flood in the Illinois River was light and there was no property loss.

Missouri River drainage.—Some flooding occurred in most of the tributaries of the Missouri in Iowa early in March as a result of the spring break-up of the ice. An ice gorge formed just below Akron, Iowa, on the Big Sioux River on March 7, and a stage of 13.0 feet was reached on March 10 but no damage occurred. On March 12 an ice gorge formed 4 miles above the mouth of the Big Sioux and the ice was blocked for a distance of 8 or 9 miles upstream, resulting in considerable overflowing but no damage of consequence resulted.

The Grand River in Missouri had a moderate flood on March 4 to 7, in the upper reaches. The flood was rather strong in the vicinity of Chillicothe, Mo., due to run-off from melting ice and snow but little damage was reported. The total loss in the Grand River flood is estimated at about $3,400.

Ohio River Drainage.—Flood stage was exceeded during the month only at Anderson, Ind., on the West Fork of White River, where the stage reached was only 0.6 foot above flood stage on March 25–26.

Red River Drainage.—High water continued in the Black River from February into March and a crest of 55.8 feet was reached at Jonesville, La., on March 4 to 7. The stage was still above flood at the close of the month.

Minor floods occurred in the Sulphur River in Texas during the month but losses were small.

Lower Mississippi drainage.—There was a gradual recession of the high water of the January-February flood during March. The Yazoo River remained above flood stage at Yazoo City, Miss., until March 31. The last station on the lower Mississippi River proper to pass below flood stage was Baton Rouge, La., on March 23.

High water also continued in the Atchafalaya River, and at Atchafalaya, La., the river was still above flood stage at the close of the month.

West Gulf of Mexico drainage.—Light flooding occurred in the Trinity and Guadalupe Rivers. No losses were reported.

Colorado River drainage.—A series of moderate floods in the lower Gila River between Gila Bend and Yuma, Ariz., caused total estimated damages of about $8,000. The greatest damage occurred at the time of the high water on the 27th and 28th, especially damage to crops. Gage heights are not available as the Bureau does not maintain stations on that portion of the river.

Pacific Slope drainage.—The rivers in the Sacramento and San Joaquin Basins were swollen from frequent rains in February and the first half of March. Heavy precipitation during the third week of March caused further rises in the streams. Flood stage, however, was exceeded only in the Cosumnes-Mokelumne River section. The crest stage, 14.4 feet on March 23, at Bensons Ferry, Calif., on the Mokelumne River, was within a tenth of a foot of the highest stage of record at that place.

The following report on the floods in this area was received from the Sacramento, Calif., office:

> Frequent rains during February and the first half of March kept the streams of the Sacramento and San Joaquin systems swollen. During the third week in March a series of storms moving from the ocean inland over northern California brought exceptionally heavy precipitation to the region from the Mokelumne River northward to Mount Shasta, mostly in the form of snow above the 2,500-foot level. For this reason, the area of effective run-off was limited to the foothills, while an unusually heavy snow cover accumulated in the Sierra down to intermediate elevations, which are usually bare at this season of the year. Had the precipitation been rain to high levels, as is usual in spring storms, a major flood would have resulted in the valley streams.
>
> As it was, a serious flood condition occurred only in the Cosumnes-Mokelumne River section, where the flood crest, as indicated by the river station at Bensons Ferry on March 23, was 14.4 feet, or 2.4 feet above the flood stage; the highest of record is 14.5 feet in 1907 and also in 1911.
>
> As the water from the upper Mokelumne was mostly going into storage in Pardee Dam, the flood was caused mainly by the output of the Cosumnes River, Dry Creek, and other local drains from the foothills. Several thousand acres of land along the left bank of the Mokelumne River, between the Cosumnes River and Dry Creek, were under water. But as it was mostly grazing land, the resultant damage in that section was almost negligible.
>
> Bear Creek in San Joaquin County flooded a large acreage in the Lodi district, causing considerable damage locally to crops and farm property, and some livestock were drowned.
>
> On the Sacramento River the stage was near the flood level in the vicinity of Knights Landing, Calif., for several days, and the water pouring over the nearly 2-mile long Fremont Weir caused increasingly high water in the Yolo Bypass region, and on March 23, the Little Holland tract, comprising about 2,800 acres of grain

and sugar-beet land, was flooded. No other reclaimed land in the Yolo Basin was inundated.

The losses incurred in the Sacramento Basin are estimated at about $45,000, mostly to prospective crops. The figures for the estimated losses in the San Joaquin Basin flood are not available at this time but will be reported in a later issue of the REVIEW.

CORRECTIONS FOR FEBRUARY 1937 REVIEW, PAGE 86, TABLE OF FLOOD STAGES

Date of crest at Yazoo City, Miss., "Feb. 24" should be "Feb. 24, Mar. 1."

Dates above flood stage: Greenville, Miss. "To Mar. 8" should be "To Mar. 12." Vicksburg, Miss., "To Mar. 15" should be "To Mar. 14."

Table of flood stages during March 1937

[All dates in March unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE	*Feet*			*Feet*	
Peedee: Mars Bluff Bridge, S. C.	17	Feb. 24	1	17.6	Feb. 26, 27
Santee:					
Rimini, S. C.	12	Dec. 31	(1)	18.8	Feb. 10
				13.6	28
Ferguson, S. C.	12	Jan. 1	(1)	14.2	Jan. 10, 11
Savannah:					
Ellenton, S. C.	14	Jan. 16	5	21.2	Feb. 13
		12	13	14.2	13
		17	30	17.3	19
Clyo, Ga.	13	Jan. 26	9	16.6	Feb. 18
				16.0	2
Ogeechee: Dover, Ga.	7	3	5	7.2	4
Ocmulgee: Abbeville, Ga.	11	Feb. 27	3	12.1	1
		24	29	11.9	27
Altamaha:					
Charlotte, Ga.	12	Jan. 28	9	15.9	Feb. 22
				15.7	3, 4
		22	(1)	14.8	29, 30
Everett City, Ga.	10	Feb. 22	11	10.8	Feb. 26
EAST GULF OF MEXICO DRAINAGE					
Apalachicola: Blountstown, Fla.	15	Jan. 21	8	19.5	Feb. 26
		22	(1)	19.9	25
Cahaba: Centerville, Ala.	23	20	21	28.6	20
Alabama: Millers Ferry, Ala.	40	24	26	42.2	25
Tombigbee:					
Lock No. 4, Demopolis, Ala.	39	22	26	41.6	24
Lock No. 3	33	Jan. 2	1	57.9	Feb. 2
		21	31	43.9	25
Lock No. 2	46	25	26	46.1	25
Lock No. 1	31	Jan. 5	2	40.2	Feb. 4-6
		23	(1)	34.3	27
Pearl:					
Jackson, Miss.	18	Feb. 25	5	21.0	1
		27	29	18.2	28
Pearl River, La.	12	Feb. 26	15	12.8	Feb. 28
		24	(1)	13.2	27

Table of flood stages during March 1937—Continued

[All dates in March unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM					
Upper Mississippi Basin	*Feet*			*Feet*	
Rock: Moline, Ill.	10	Feb. 21	18	14.7	6
Cedar: Cedar Rapids, Iowa	13	9	9	13.7	9
Iowa:					
Iowa City, Iowa	8	3	16	14.6	7
Wapello, Iowa	10	6	15	14.6	8
Skunk: Augusta, Iowa	15	7	7	15.1	7
		12	12	15.5	12
Raccoon: Van Meter, Iowa	13	4	4	14.0	4
		6	6	14.0	6
Des Moines:					
Tracy, Iowa	14	4	10	17.9	5
Ottumwa, Iowa	9	5	10	14.7	6
Illinois:					
Havana, Ill.	14	Feb. 22	5	14.7	Feb. 26
Beardstown, Ill.	14	Feb. 23	6	15.1	Feb. 27, 28
Mississippi:					
Keithsburg, Ill.	12	8	13	13.2	10
Keokuk, Iowa	12	7	15	16.1	10
Quincy, Ill.	14	7	16	18.2	11
Hannibal, Mo.	13	7	17	17.8	12
Grafton, Ill.	18	14	16	18.2	15
Missouri Basin					
Grand:					
Gallatin, Mo.	20	4	5	22.8	5
Chillicothe, Mo.	18	4	7	25.2	5
Big Sioux: Akron, Iowa	12	7	[2] 10	13.0	10
Ohio Basin					
West Fork of White: Anderson, Ind.	8	5	9	8.0	5-9
		21	31	8.6	25, 26
Red Basin					
Black: Jonesville, La.	50	Feb. 9	(1)	55.8	4-7
Sulphur:					
Ringo Crossing, Tex.	20	5	9	22.7	5
		15	15	21.1	15
Naples, Tex.	22	24	27	22.6	24
		8	20	25.8	11
		26	(1)	26.6	29
Lower Mississippi Basin					
Yazoo: Yazoo City, Miss.	29	Jan. 20	31	37.1	Feb. 24, 1
Atchafalaya Basin					
Atchafalaya: Atchafalaya, La.	22	Jan. 22	(1)	25.9	7-9
WEST GULF OF MEXICO DRAINAGE					
Trinity: Liberty, Tex.	24	16	18	24.3	17, 18
Guadalupe: Victoria, Tex.	21	8	9	22.4	9
PACIFIC SLOPE DRAINAGE					
San Joaquin Basin					
Mokelumne: Bensons Ferry, Calif.	12	22	24	14.4	23

[1] Continued into April. [2] Fell slightly below flood stage on 9th.

WEATHER ON THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, I. R. TANNEHILL in charge]

NORTH ATLANTIC OCEAN, MARCH 1937

By H. C. HUNTER

Atmospheric pressure.—The northeastern and north-central portions of the North Atlantic had much higher pressure averages than normal; so that the Iceland region had about as high averages as any part of the ocean area, and the chief low-pressure region was far to the southeastward, near the southern parts of the British Isles and the North Sea. At Horta the pressure averaged moderately below normal, and the Azores high likewise had moved southeastward to the Madeira-Canaries region. As for western portions, pressure was somewhat below normal near the Gulf of St. Lawrence and for considerable distances to southward and southeastward; but the departures decreased to southwestward, so that for the Gulf of Mexico as a whole pressure was near normal.

The extremes of pressure indicated by vessel reports are 30.53 and 28.45 inches. The higher reading was noted on the Italian steamship *Ida Z. O.*, on the forenoon of the 17th, near 33° N., 42° W. Reykjavik, Iceland, on the 8th had slightly greater pressure, as table 1 shows. The lower reading was made on the American liner *Manhattan*, early on the 15th, near 48° N., 32° W.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, March 1937*

Stations	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Julianehaab, Greenland	29.88	+0.21	30.48	10	29.18	2
Reykjavik, Iceland	30.08	+.40	30.59	8	28.88	31
Lerwick, Shetland Islands	29.75	+.05	30.36	30	29.21	14
Valencia, Ireland	29.61	−.29	30.18	29	28.79	11
Lisbon, Portugal	29.99	−.01	30.30	1	29.29	4
Madeira	30.09	+.06	30.27	1	29.81	13
Horta, Azores	30.03	−.15	30.38	7	29.70	14
Belle Isle, Newfoundland	29.63	−.20	30.30	16	28.92	24
Halifax, Nova Scotia	29.77	−.19	30.26	4, 15	29.20	29
Nantucket	29.84	−.14	30.40	3	29.29	16
Hatteras	29.98	−.06	30.48	3	29.57	25
Bermuda	29.98	−.16	30.40	4	29.42	28
Turks Island	29.98	−.04	30.12	4	29.83	28
Key West	29.98	−.07	30.29	30	29.77	27
New Orleans	30.07	+.03	30.47	2	29.69	24

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

Cyclones and gales.—The chief turbulent periods of March on the North Atlantic were the first 6 days and the period from the 14th to 17th. During the earlier period the ocean area showed several strong centers of low pressure. One was in the vicinity of the Bay of Biscay about the 3d to 5th, resulting in intense winds over a large area, particularly in northwest gales between the Azores and the Iberian Peninsula. On the eastbound Italian liner *Rex* one fatality and numerous injuries resulted from high seas encountered.

Another LOW, near mid-Atlantic about 45° north latitude, on the 4th and 5th, showed pressure considerably below 29 inches. In connection with this, the first instance of force-12 wind during the month was noted, the liner *American Importer* meeting it near 46° N., 40° W., on the 4th, while bound from Belfast to Boston. It was more than 48 hours later, in connection with still another storm center, that the second occurrence of hurricane winds was noted, this being the final instance of such force in March over the North Atlantic insofar as reports are now available. This center hovered near the Gulf of St. Lawrence and Newfoundland from the 4th to the 8th, and about 500 miles to south-southeastward of Cape Race the American steamship *Exminster*, Lisbon to New York, noted force 12 late on the 6th.

A disturbance of much importance to the waters just east of the United States was centered near Savannah, Ga., on the morning of the 15th, whence it moved northeastward to near Long Island, and then more to northward to the heart of the Province of Quebec. Strong winds were encountered by vessels near the coast, as shown on chart IX, which presents the conditions on the 16th. A LOW of even greater intensity appears on this chart about 500 miles west-southwest of Ireland, where vessels passing between English Channel ports and the northeastern United States were reporting some of the lowest pressure readings of the month.

The winds and seas connected with a vigorous LOW, located on the 22d to southeastward of Nova Scotia, were probably the chief factors in causing the distress of the Norwegian steamship *Bjerkli*, which sank late on the 23d near 40° N., 58° W., the crew being rescued by the cutter *Chelan*.

During the 25th a LOW of considerable and rapidly increasing energy crossed the coast line eastward near New Jersey and advanced to the southern tip of the Grand Banks, becoming part of a large low-pressure system which covered the region embracing the St. Lawrence Gulf, southern Greenland and the midocean area for several days, and, in conjunction with a very strong HIGH centered usually over or near Manitoba, caused strong offshore winds near the eastern coast of the United States. The situation on the 26th is presented on chart X.

Strong winds in or near the Tropics.—About the 8th a strong norther near Tuxpam, in the western Gulf of Mexico, caused the stranding of three barges, one of which broke in two and became a total loss. A fourth barge was apparently lost off shore.

The British steamship *Jamaica Merchant*, approaching Vera Cruz on the 15th, was overtaken by a norther of marked intensity (force 9), but made port readily.

Harbour Island, in the northwestern part of the Bahama group, reported a tornado on the 31st. A small area was affected, with destruction of nine houses; one woman was reported killed, with two other persons hurt.

Ice.—Densely packed ice prevailed in the vicinity of St. Johns, Newfoundland, almost or quite all the month. Several steamers that tried to force their way through were damaged as to bow or propeller; and one outward-bound steamer (British *Delia*) was crushed till leaking so badly that it was abandoned a few miles west of Cape Race; the crew walked ashore.

Fog.—The Atlantic Ocean, as a whole, had less fog than usual during March. It was particularly the case with the portion along the chief steamship lanes to northwestern Europe from the 40th meridian eastward that there was less fog than during February just preceding. Indeed, from the Bay of Biscay and the waters around it and for about 700 miles to westward reports indicate almost complete absence of fog.

From the eastern limits of the Grand Banks to the eastern coast of the United States and from Maine to South Carolina there was generally an increase of fog from February to March; but in most areas the increase was not so great as usually occurs at this time of year. From the waters directly south of Newfoundland westward to Cape Cod the March fogginess was still far below the normal for the month; while in the 5° square, 35° to 40° N., 70° to 75° W., the square considered to have the most fog of North Atlantic areas, there were 8 days with fog, or about the expected amount for this vicinity.

In lower latitudes of the western North Atlantic there were a few notable fog reports. The grounding of the Norwegian steamship *Iristo* on a reef on the north side of Bermuda, during the night of the 14–15th, is believed to have been due to fog. The vessel was soon refloated, but sank while trying to make port, all hands being saved. Northeast of the Bahama group fog was noted on the 21st. In the Gulf of Mexico a little fog was seen about this time near western Cuba, while in the northwestern Gulf fog was more prevalent than often happens in March, being observed on 7 days, all in the period from 18th to 26th, inclusive.

OCEAN GALES AND STORMS, MARCH 1937

Vessel	Voyage From—	Voyage To—	Position at time of lowest barometer: Latitude	Position at time of lowest barometer: Longitude	Gale began March	Time of lowest barometer March	Gale ended March	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
NORTH ATLANTIC OCEAN			° ′	° ′				Inches					
Exchange, Am. S. S.	Lisbon	New York	35 56 N.	63 00 W.	[1] 28	2a, 1	1	29.44	S	S, 10	NNW	SSW, 10	S-WNW.
Collamer, Am. S. S.	Havre	do	42 00 N.	41 50 W.	1	4a, 2	2	29.34	S	SW, 10	NW	W, 11	S-W.
Bilderdijk, Du. S. S.	Rotterdam	do	44 58 N.	42 21 W.	2	6a, 2	2	28.98	SSW	WSW, 6	NNW	N, 10	SSW-NNW.
Binnendijk, Du. S. S.	do	do	44 42 N.	40 15 W.	2	8a, 2	2	[2] 29.07	ESE	SSW, 10	NW	WNW, 11	ESE-SSW-NNW.
West Cohas, Am. S. S.	Liverpool	Port Sulphur	[3] 43 32 N.	19 19 W.	3	8a, 3	4	29.06	SSW	WSW, —	NNW	NNW, 10	SSW-NNW.
Damsterdijk, Du. M. S.	Swansea	Cristobal	40 24 N.	21 35 W.	3	8a, 3	4	[2] 29.55	WSW	W, 9	NNW	WNW, 11	WSW-NW.
Peebles, Br. M. S.	Buenos Aires	Liverpool	[3] 42 35 N.	12 09 W.	4	8p, 3	4	28.90	NW	W, 6	NW	NW, 9	SW-NW.
Exminster, Am. S. S.	Lisbon	New York	37 58 N.	41 38 W.	3	1a, 4	5	29.65	SSW	WSW, 9	NW	WNW, 10	WSW-W.
American Importer, Am. S. S.	Belfast	Boston	45 55 N.	39 32 W.	4	Noon, 4	5	28.68	SSE	SW, 9	WNW	WSW, 12	SE-W.
Veendam, Du. S. S.	New York	Rotterdam	46 29 N.	38 44 W.	3	5p, 4	5	28.54	ENE	NNW, —	S	ENE, 9	NE-NNW-WSW.
Edam, Du. S. S.	Southampton	New York	45 44 N.	34 29 W.	5	6p, 5	6	[2] 28.87	SW	WSW, 11	NW	W, 11	SSW-WNW.
Exminster, Am. S. S.	Lisbon	do	38 05 N.	49 30 W.	5	5p, 6	6	29.61	SW	S, 12	W	S, 12	S-NW.
Do	do	do	38 01 N.	52 10 W.	7	6p, 7	7	29.68	SW	WSW, 11	W	WSW, 11	SW-W.
Quaker City, Am. S. S.	Dundee	Boston	51 51 N.	33 42 W.	9	Noon, 9	9	29.50	ESE	ESE, 9	E	ESE, 9	E-SE.
Chesapeake, Br. M. S.	Nyborg	Aruba	44 54 N.	38 38 W.	11	Noon, 11	12	29.41	NW	ENE, 6	NW	WNW, 10	ESE-ENE-NW.
Cavina, Br. S. S.	Avonmouth	Kingston	[3] 42 46 N.	25 44 W.	12	1a, 12	13	29.26	W	WSW, 4	W	WNW, 10	ESE-WSW-W.
Waban, Am. S. S.	Rotterdam	New Orleans	42 20 N.	20 17 W.	12	10a, 13	13	29.14	NW	NW, —	WNW	NW, 10	NW-WNW-NW.
Themisto, Du. S. S.	St. Vincent, C. V. Is.	Antwerp	41 50 N.	13 00 W.	13	6p, 13	14	29.35	W	WNW, 10	NW	WNW, 10	W-WNW.
Jamaica Merchant, Br. S. S.	New Orleans	Vera Cruz	23 46 N.	93 00 W.	15	6a, 14	15	29.85	NNW	SSE, 3	N	N, 9	
Europa, Ger. S. S.	Cherbourg	New York	46 16 N.	34 52 W.	14	9p, 14	15	[2] 28.64	SSE	W, 11	WNW	W, 11	SSE-SW-WNW.
Manhattan, Am. S. S.	Cobh	do	47 32 N.	31 54 W.	15	4a, 15	15	28.45	S	S, 8	N	NNW, 9	S-NW.
Tulsa, Am. S. S.	Bremen	Wilmington, N. C.	47 45 N.	19 20 W.	15	11 p, 15	19	[2] 28.53	SSE	SW, 10	NW	SW, 10	SSE-WSW.
Stelvio, Ital. M. S.	Preston	Houston	44 55 N.	22 00 W.	15	2a, 16	18	29.20	SSW	SW, 10	NW	SW, 11	SW-WSW.
American Trader, Am. S. S.	London	Boston	48 45 N.	20 50 W.	15	4a, 16	17	28.55	SE	S, 3	NNW	N, 10	S-NNW-WNW.
West Chatala, Am. S. S.	Liverpool	Beaumont	49 32 N.	14 02 W.	15	11a, 16	18	28.74	SE	SW, 10	W	SW, 10	S-SW.
Marina O., Ital. S. S.	Lisbon	New York	35 30 N.	70 15 W.	16	3p, 16	17	29.53	WSW	WSW, 8	WNW	WNW, 10	WSW-WNW.
Tabinta, Du. M. S.	St. Vincent, C. V. Is.	Boston	35 47 N.	53 20 W.	22	8a, 22	25	29.64	WNW	WNW, 6	SW	NW, 10	
Pres. Roosevelt, Am. S. S.	New York	Cobh	46 35 N.	32 50 W.	22	2p, 22	23	29.58	ESE	SE, 8	SE	SE, 10	ESE-SE.
Mendota, U. S. C. G. C.	On ice patrol out from Halifax.		43 48 N.	55 48 W.	23	8p, 22	24	28.91	WNW	WNW, 6	WNW	WNW, 10	SE-WNW.
Spidoleine, Belg. M. S.	Antwerp	New York	46 20 N.	34 26 W.	26	2a, 27	28	28.93	WSW	SSE, 8	WSW	WSW, 9	SSE-SSW.
Excambion, Am. S. S.	Gibraltar	Boston	42 18 N.	49 48 W.	27	9p, 27	27	29.12	SE	WSW, 9	WSW	WSW, 10	SE-WSW.
Ile de France, Fr. S. S.	Havre	New York	45 36 N.	41 30 W.	27	2a, 28	28	28.83	SSW	SW, 8	W	W, 10	SSW-W.
Sagadahoc, Am. S. S.	Trinidad	Boston	40 34 N.	69 36 W.	25	Noon, 28	27	29.35	WSW	N, 5	NW	NW, 10	
Spidoleine, Belg. M. S.	Antwerp	New York	43 34 N.	43 06 W.	29	10a, 29	29	28.61	E	SSW, 10	WNW	SSW, 10	SE-SSW-NW.
Black Gull, Am. S. S.	Rotterdam	do	45 42 N.	37 54 W.	29	5p, 29	30	28.70	SW	SW, 10	W	SW, 10	SW-NW.
NORTH PACIFIC OCEAN													
Golden Tide, Am. S. S.	San Francisco	Yokohama	29 02 N.	163 30 W.	[1] 28	5p, 28 [1]	2	29.62	SW	W, 9	N	N, 10	W-NW.
Gen. Pershing, Am. S. S.	Portland, Oreg.	do	49 00 N.	170 00 E.	1	Noon, 1	2	29.81	S	S, 9	NW	S, 9	S-NW.
Maliko, Am. S. S.	Seattle	Honolulu	33 18 N.	147 00 W.	1	3p, 1	2	29.53	S	S, 9	SW	S, 9	None.
Alaskan, Am. S. S.	San Francisco	Balboa	15 08 N.	93 11 W.	1	4p, 1	1	29.84	NNE	NNW, 6	NW	NNW, 9	
Illinois, Am. S. S.	Portland, Oreg.	Yokohama	49 57 N.	176 35 E.	1	Mdt, 1	2	29.94	S	S, 9	NW	S, 10	S-NW.
Pres. Pierce, Am. S. S.	Los Angeles	Balboa	13 30 N.	93 48 W.	1	Noon, 2	2	29.83	NE	NE, 7	NNW	NNW, 8	
Foylebank, Br. M. S.	San Francisco	Manila	30 32 N.	142 43 W.	2	2p, 2		29.60	SSE	S, 9	S	S, 9	S-WNW.
Pres. Grant, Am. S. S.	Victoria, B. C.	Yokohama	52 25 N.	158 45 W.	3	6a, 3	3	29.54	W	W, 8	N	N, 9	W-NNE.
Makua, Am. S. S.	Seattle	Honolulu	41 12 N.	137 40 W.	2	8p, 3	3	29.40	SSE	S, 7	SSE	SSE, 9	SSE-SW.
Pleasantville, Nor. M. S.	Vancouver, B. C.	Shanghai	39 48 N.	137 15 E.	4	Noon, 4	5	29.09	W	SW, 7	N	NW, 9	SSE-SW-NW.
Pres. Grant, Am. S. S.	Victoria, B. C.	Yokohama	[3] 51 45 N.	171 24 W.	4	3p, 4	5	29.79	NW	NW, 8	NW	NW, 9	WSW-NNW.
Gen. Pershing, Am. S. S.	Portland, Oreg.	do	42 18 N.	148 24 E.	4	3a, 5	6	28.99	ESE	S, 5	WNW	W, 9	SSE-WSW.
Azumasan Maru, Jap. M. S.	Yokohama	Los Angeles	44 59 N.	149 04 W.	5	Noon, 5	6	29.18	S	S, 8	SSW	WSW, 9	SSE-WSW.
Illinois, Am. S. S.	Portland, Oreg.	Yokohama	44 48 N.	157 08 E.	5	11p, 5	7	29.16	SE	NW, 2	W	SSE, 9	S-NW.
Fujisan Maru, Jap. M. S.	Los Angeles	Tokuyama	34 19 N.	152 04 W.	6	Noon, 6	6	29.84	W	W, 8	NW	W, 8	W-NNW.
Shintoku Maru, Jap. B.	Ponape	Usuki, Oita	27 35 N.	134 07 E.	8	9p, 8	8	[2] 29.60	E	NE, 7	NNE	NNE, 8	E-NNE.
Manini, Am. S. S.	Olympia	Port Allen	44 54 N.	132 00 W.	7	4p, 8	9	29.42	SE	S, 8	WSW	S, 9	S-SW
Pres. Grant, Am. S. S.	Victoria, B. C.	Yokohama	45 53 N.	160 15 E.	8	Mdt, 8	9	28.95	SSE	S, 7	WNW	NW, 10	SE-S-W
California, Am. S. S.	Portland, Oreg.	Shanghai	48 25 N.	164 20 E.	8	3a, 9	9	28.94	SE	S, 9	W	SSE, 9	SE-SW.
Mauna Kea, Am. S. S.	Balboa	San Diego	14 46 N.	95 54 W.	9	4p, 9	9	29.67	N	NE, 8	ENE	N, 8	N-NE.
Empress of Japan, Br. S. S.	Honolulu	Victoria, B. C.	41 49 N.	136 19 W.	10	Mdt, 10	10	29.16	SW	SE, 5	SE	NW, 8	N-SE-E.
Golden Tide, Am. S. S.	San Francisco	Yokohama	29 15 N.	162 35 E.	10	2p, 10	11	29.68	SE	SSW, 7	NNE	WSW, 9	S-W.
Nagara Maru, Jap. M. S.	Yokohama	Los Angeles	44 31 N.	169 06 E.	10	8a, 11	12	28.74	ENE	SSW, 10	SW	WSW, 11	ENE-SW.
Kiyo Maru, Jap. M. S.	Fusan	do	45 36 N.	162 52 E.	10	1p, 11	12	29.23	N	WNW, 10	SW	WNW, 10	NW-W.
Shintoku Maru, Jap. B.	Ponape	Usuki, Oita	29 00 N.	132 35 E.	11	Noon, 11	11	[2] 29.53	S	SW, 8	WNW	SSW, 9	S-W.
Manini, Am. S. S.	Olympia	Port Allen	39 37 N.	140 10 W.	11	Mdt, 11	12	29.25	NW	NW, 9	NW	NW, 10	
Empress of Russia, Br. S. S.	Vancouver, B. C.	Yokohama	51 12 N.	176 40 W.	11	2p, 11	12	29.15	SW	SW, 11	SW	SW, 11	None.
Asama Maru, Jap. M. S.	Yokohama	Honolulu	34 48 N.	140 12 E.	11	9p, 11	12	29.33	N	N, 8	N	N, 8	
Taketoyo Maru, Jap. S. S.	do	Los Angeles	30 15 N.	151 54 E.	11	4a, 12	13	29.31	S	S, 9	NW	SSW, 9	S-W.
Toho Maru, Jap. M. S.	Tokuyama	do	36 50 N.	150 15 E.	11	4a, 12	12	29.52	SSW	S, 9	NW	S, 9	S-SW.
Kiyo Maru, Jap. M. S.	Fusan	do	46 28 N.	170 55 E.	12	Mdt, 12	13	29.55	SSW	SSW, 9	W	SSW, 9	SSW-SW.
Empress of Russia, Br. S. S.	Vancouver, B. C.	Yokohama	49 49 N.	179 08 E.	12	Noon, 13	14	29.36	SW	WSW, 8	W	W, 9	SW-WSW.
Neches, U. S. N.	Los Angeles	Honolulu	30 45 N.	132 51 W.	15	6p, 14	15	29.66	NW	W, 6	NNW	NW, 8	W-NNW.

[1] February. [2] Barometer uncorrected. [3] Position approximate.

OCEAN GALES AND STORMS, MARCH 1937—Continued

Vessel	Voyage: From—	Voyage: To—	Position at time of lowest barometer: Latitude	Position at time of lowest barometer: Longitude	Gale began March	Time of lowest barometer March	Gale ended March	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
NORTH PACIFIC OCEAN—Continued			° ′	° ′				Inches					
Kentuckian, Am. S. S.	Portland, Oreg.	Balboa	34 30 N.	121 10 W.	15	2p, 15	15	29.79	SE	SE, 8	SE	SE, 8	SE-S.
Bengalen, Du. M. S.	Cebu	Portland, Oreg.	41 37 N.	141 00 W.	16	8p, 16	16	30.32	NW	NW, 8	NW	NW, 8	None.
Empress of Russia, Br. S. S.	Vancouver, B. C.	Yokohama	38 30 N.	145 09 E.	17	4p, 17	18	29.25	W	W, 9	NW	WNW, 12	W-WNW.
Pres. Jackson, Am. S. S.	Seattle	do	52 35 N.	153 05 W.	17	6a, 17	18	29.31	NW	SSW, 2	NNW	NW, 9	SSW-W.
Kwanto Maru, Jap. M. S.	Yokohama	Los Angeles	46 29 N.	176 37 W.	18	11p, 17	18	29.71	E	E, 8	S	E, 9	E-SSE.
Forbes Hauptman, Am. S. S.	Balboa	do	29 00 N.	115 51 W.	18	4p, 18	18	30.10	WNW	WNW, 7	NW	WNW, 8	None.
Diamond Head, Am. S. S.	Port Townsend	Port Allen	42 00 N.	137 18 W.	18	6p, 18	19	29.87	SW	W, 8	WNW	WNW, 9	None.
Nitro, U. S. N.	San Francisco	Manila	[1]35 45 N.	129 06 W.	20	9p, 20	21	29.74	S	N, 8	NNW	N, 8	S-N.
Empress of Asia, Br. S. S.	Yokohama	Victoria, B. C.	49 21 N.	177 50 E.	21	4p, 22	22	29.28	E	E, 9	SE	E, 10	E-SE.
Kwanto Maru, Jap. M. S.	do	Los Angeles	41 02 N.	135 15 W.	22	Noon, 23	24	29.65	WNW	W, 8	N	W, 8	WNW-W.
Pres. McKinley, Am. S. S.	do	Victoria, B. C.	42 41 N.	155 35 E.	24	4a, 25	25	29.63	NNW	NW, 9	N	NW, 10	NW-N.
Gen. Pershing, Am. S. S.	Hong Kong	Kobe	[1]25 30 N.	121 26 E.	25	2a, 25	25	30.12	NNE	NNE, 8	NNE	NNE, 8	
Pres. McKinley, Am. S. S.	Yokohama	Victoria, B. C.	47 17 N.	174 49 E.	27	Noon, 27	27	29.10	SSE	SE, 8	SW	SE, 8	SE-SW.

[1] Position approximate.

NORTH PACIFIC OCEAN, MARCH 1937

By WILLIS E. HURD

Atmospheric pressure.—Owing to the considerable amount of cyclonic activity on the North Pacific Ocean during March 1937, average pressures for the most part were below the normal. As shown by table 1, pressures in the Pacific area were above normal only at Dutch Harbor, Kodiak, and Midway Island, and at those stations only by small amounts.

The Aleutian LOW, within the isobar of 29.80 inches, occupied on the average an enormous region extending east-west between the Gulf of Alaska and extreme northern Japan, and north-south over much of the Bering Sea, and the northern part of the ocean to the southward of the Aleutian Islands.

The North Pacific HIGH overlay the central part of the ocean, with average pressure, 30.12 inches, at Midway Island.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, March 1937, at selected stations*

Station	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	Inch	Inches		Inches	
Point Barrow	30.23	+0.08	30.90	26	29.20	15
Dutch Harbor	29.79	+.09	30.46	19	29.06	14
St. Paul	29.71	−.02	30.54	19	28.68	14
Kodiak	29.71	+.02	30.20	20	29.18	15
Juneau	29.83	−.11	30.31	27	29.37	5
Tatoosh Island	29.93	−.03	30.38	6	29.44	12
San Francisco	29.99	−.07	30.28	2	29.41	12
Mazatlan	29.88	−.04	29.96	3, 4, 5, 18	29.80	10, 15
Honolulu	29.99	−.05	30.18	31	29.77	1
Midway Island	30.12	+.05	30.28	13	29.74	24
Guam	29.84	−.06	29.92	13, 22, 23, 28	29.56	24
Manila	29.84	−.02	29.92	13, 22	29.74	22
Hong Kong	29.88	−.10	30.04	25	29.69	10
Nemuro	29.81		30.15	1, 14, 23	28.74	4

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observation.

Cyclones and gales.—March 1937 was the stormiest month on the North Pacific since November 1936. This was not so much due to winds of extremely high force as to the persistency with which cyclones occupied certain parts of the ocean and to the general frequency of gales within the great disturbed regions.

The principal regions of cyclonic activity were two—one comprising the northwestern part of the ocean from middle longitudes to Japan; the other, the eastern part of the ocean, between about 30° and 50° latitude.

The gales in the northwestern area were due to eastward-traveling cyclones from Siberia and middle Japanese waters and to a fluctuating oceanic cyclone over and to the northward of the upper western steamship routes. Here the most violent gales of the month, according to ships' reports now at hand, occurred on the 11th and 17th: On the 11th, of force 11, as encountered by the Japanese motorship *Nagara Maru*, near 44½° N., 169° E., barometer 28.74, and, also of force 11, as encountered by the British steamship *Empress of Russia*, barometer 29.15, near 51° N., 177° W. On the 17th the *Empress of Russia* reported the most severe wind of the month, when involved in a west-northwest hurricane, barometer 29.25, in 38°30′ N., 145°09′ E.

On March 1 strong to whole southerly gales occurred south of the western Aleutians. On the 2d of the month a LOW developed over the southern waters of the Yellow Sea. It moved northeastward across Japan and by the 5th, when central near the Kuril Islands, was of great depth. On that date it caused fresh to strong gales over most east-Japanese waters. On the succeeding 3 days the cyclone moved slowly toward and into the Bering Sea, where it remained from the 7th until about the 20th, causing strong to storm gales (force 9–11) from the 9th to the 13th along the northern routes between midocean and longitude 160° E., and more scattered storminess on succeeding dates. During the movement of this cyclone over southern Kamchatka waters on the 6th, a press report of that date from Petropavlovsk stated that a destructive hurricane was occurring along the coast of the peninsula.

On March 15 a Siberian Low entered the Japan Sea and moved eastward across Japan. On the 17th, centered east of Hokushu, it was causing gales which continued into the 18th east of Japan. It was this storm which on the 17th caused the hurricane velocity earlier mentioned as experienced by the S. S. *Empress of Russia*. The disturbance deepened as it moved northeastward toward the western Aleutians, and on the 22d the American steamship *President Jackson* was near the center at about 50° N., 166° E., and reported the lowest barometer reading of the month,

28.35 inches, accompanied by an east gale of force 8. The British steamship *Empress of Asia*, to the eastward of the *President Jackson's* position on that date, encountered a gale of force 10. Thereafter the storm moved into the Bering Sea. Press reports indicate that the American steamship *Volunteer*, when about 1,000 miles out from Kobe late in the month, was disabled by heavy weather while bound for Japan, but that she succeeded in making port under her own power on April 4.

Stormy weather began early in the month over central latitudes of the eastern part of the ocean. On the 1st and 2d an extensive depression lay between the Hawaiian Islands and the Gulf of Alaska, and as a result ships experienced moderate to strong local gales over a considerable stretch of water to the north, northeast, and east of Honolulu. The disturbance advanced northward on the 3d, but thereafter made little progress until the 16th when it went inland over southern California. Throughout its path, rough weather with local moderate to strong gales was of practically daily occurrence within the region bounded approximately by latitudes 30° and 50°, and longitude 155° W. and the American coast. The strongest gale reported during the period was of force 10, on the 11th, within the square 35°–40° N., 140°–145° W.

A minor disturbance lay off the coast of British Columbia, Washington, and Oregon from the 18th to the 24th, and caused fresh to strong gales within its area on at least 3 of the 7 days of its existence at sea.

In other parts of the ocean, specific mention may be made of fresh to whole gales which occurred east of Midway Island on the 1st; of a fresh gale reported off Lower California on the 18th; and of a strong monsoon current of fresh gale force in the north entrance of Taiwan Channel on the 25th.

Tehuantepecers.—In the Gulf of Tehuantepec northerly gales were reported as follows: Of force 7 on the 13th, of force 8 on the 2d and 9th, and of force 9 on the 1st.

Fog.—There were 12 days reported by ships as having fog off the California coast, and 3 days off Lower California. Fog was encountered on the 1st to 4th a day or two outbound from San Francisco, and on the 23d to 30th in localities between 40°–50° N., 135°–175° W.

Some accidents due to fog were reported by the press On the 2d the seiner *Advance* was grounded in dense fog near San Francisco; and on the early afternoon of the 6th the steamship *President Coolidge* collided with the tanker *Frank H. Buck* nearly underneath the Golden Gate Bridge. The tanker was sunk and the liner was injured, but put back for repairs after taking on the crew of 40 from the other craft. In a collision between the trawler *Normandie* and the steamship *Alama* 12 miles off Eureka, Calif., on the night of the 10th, the trawler was sunk, but her crew was rescued. This accident was apparently due to fog, which was reported by other ships as occurring off and to the southward of Eureka on that date.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

TABLE 1.—*Condensed climatological summary of temperature and precipitation by sections, March 1937*

[For description of tables and charts, see REVIEW, January, p. 35]

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	° F.	° F.		° F.			° F.		In.	In.		In.		In.
Alabama	53.5	−2.3	Evergreen	85	22	Valley Head	20	3	4.53	−1.22	Sylacauga	8.57	Fort Payne	1.36
Arizona	50.7	−2.6	2 stations	92	[1] 10	Fort Valley	3	[1] 26	1.73	+.77	Reno Ranger Station.	4.81	Fairbank	.06
Arkansas	48.7	−3.8	Magnolia	84	19	Gilbert	14	1	3.04	−1.66	El Dorado	5.79	Mountain Home	.73
California	50.0	−1.4	El Centro	93	[1] 9	2 stations	−3	25	5.52	+1.93	Kennett	16.96	Independence	.04
Colorado	33.9	−.6	Las Animas	77	[1] 7	Hermit (near)	−17	1	1.43	+.13	Pagosa Springs (near).	13.86	Savage Ranch	.16
Florida	62.6	−2.6	Clermont	92	25	Cottage Hill	25	2	4.32	+1.16	West Palm Beach	11.72	Key West	1.18
Georgia	53.8	−2.4	Millen	84	13	Blairsville	16	2	3.69	−1.16	Moultrie	7.00	Athens no. 2	2.00
Idaho	35.5	−.3	Lapwai	74	12	Deadwood	−15	18	4.35	−.42	Deception Creek	3.49	Blackfoot	.14
Illinois	37.9	−2.2	Carbondale	75	6	4 stations	9	[1] 9	1.20	−1.82	Mascoutah	3.04	Sycamore	.32
Indiana	37.0	−3.6	2 stations	78	[1] 6	2 stations	2	11	1.45	−2.25	Whitestown	3.05	Evansville	.55
Iowa	32.9	−1.5	Sac City	76	6	Cresco	−2	9	1.63	−.09	Primghar	2.85	Cresco	.36
Kansas	40.0	−3.3	Wellington	77	7	Healy	0	15	1.65	+.23	Iola no. 1	4.35	Stockton	.33
Kentucky	42.2	−4.0	Quicksand	77	20	Cumberland	6	1	1.43	−3.24	Jenkins	2.51	Carrollton	.45
Louisiana	55.8	−4.7	Belle Chasse	86	18	2 stations	23	1	5.03	+.30	Reserve	9.58	Woodworth	2.97
Maryland-Delaware	39.4	−2.8	La Plata, Md	74	25	Sines, Md	1	1	2.02	−1.55	Princess Anne, Md	3.79	Chewsville, Md	1.05
Michigan	26.7	−3.1	2 stations	59	6	Dukes	−22	11	.66	−1.50	St. Joseph	1.94	St. Ignace	.04
Minnesota	23.1	−3.4	Pipestone	67	6	Meadowlands	−29	10	.83	−.34	Marshall	2.75	Detroit Lakes	T
Mississippi	52.8	−4.0	Hattiesburg	85	20	Kosciusko	20	1	4.26	−1.47	Pearlington	8.75	University	1.06
Missouri	40.4	−3.4	Mexico	77	7	Crystal City	6	16	1.66	−1.57	Harrisonville	3.92	Palmyra	.54
Montana	30.4	−.3	2 stations	71	[1] 5	Summit	−23	27	.78	−.17	Hebgen Dam	3.56	Westby	T

[1] Other dates also.

TABLE 1.—*Condensed climatological summary of temperature and precipitation by sections, March 1937*—Continued

[For description of tables and charts, see REVIEW, January, p. 35]

Section	Temperature: Section average	Temperature: Departure from the normal	Monthly extremes: Station	Highest	Date	Station	Lowest	Date	Precipitation: Section average	Precipitation: Departure from the normal	Greatest monthly: Station	Amount	Least monthly: Station	Amount
	° F.	° F.		° F.			° F.		In.	In.		In.		In.
Nebraska	34.8	−1.6	Madison	82	6	Harrison	−11	26	1.40	+0.31	2 stations	3.02	Sheep Creek Camp	0.15
Nevada	41.7	+1.2	Las Vegas	85	3	San Jacinto	0	19	.93	−.04	Marlette Lake	2.54	Montello	.03
New England	28.9	−3.4	Westfield, Mass	61	4	First Connecticut Lake, N. H.	−28	6	3.36	−.02	Portland, Maine	5.68	Errol, N. H	.84
New Jersey	35.8	−3.3	Burlington	66	5	3 stations	7	[1] 1	2.75	−1.03	Pleasantville	3.79	Boonton	1.94
New Mexico	40.3	−3.4	Portales Evaporation Station.	91	22	Gavilan (near)	−7	1	1.23	+.48	White Tail	4.36	Ione	.20
New York	27.3	−4.8	Glenham	62	4	Stillwater Reservoir	−22	14	2.54	−.52	North Lake	5.07	Chazy	.95
North Carolina	48.0	−1.9	New Bern	82	25	Mount Mitchell	2	16	1.98	−2.24	Parker	4.01	Asheville	.74
North Dakota	24.8	+1.2	Carson	72	6	Pembina	−20	10	.39	−.38	Fullerton	1.99	Sanish	.00
Ohio	34.9	−3.8	Ironton	75	20	Bangorville	2	10	1.65	−1.70	Warren	2.84	Montpelier	.50
Oklahoma	46.9	−3.7	Okmulgee	82	6	Goodwell	9	30	2.22	+.05	Seminole	5.90	Kenton	.60
Oregon	41.3	+.3	2 stations	75	7	Austin	−5	23	2.62	−.12	Brookings	12.56	Squaw Butte	.54
Pennsylvania	34.2	−3.4	do	67	20	Lawrenceville	−3	1	2.00	−1.50	Pleasant Mount	3.84	Ansonia	.80
South Carolina	52.3	−2.3	Kingstree	82	24	Caesars Head	17	16	2.57	−1.34	Wedgefield	3.57	Cherokee (near)	1.52
South Dakota	30.5	−.6	Dupree	79	6	2 stations	−20	26	1.44	+.33	Arlington	3.67	Pollock	.26
Tennessee	45.9	−3.5	Carthage	80	23	Erwin	1	1	2.10	−3.25	Charleston	3.58	Elizabethton	1.12
Texas	53.7	−4.8	Encinal	96	22	Miami	11	28	2.81	+.78	Liberty	9.18	Presido	.00
Utah	37.1	−1.3	3 stations	77	[1] 9	Woodruff	−9	6	1.64	+.24	Kimberly	5.49	Ibapah	.22
Virginia	42.5	−3.2	2 stations	77	25	2 stations	2	1	1.55	−2.17	Holland	3.28	Quantico	.41
Washington	43.1	+1.7	Everett	76	4	Winthrop	6	1	2.79	−1.12	Wynoochee Oxbow	12.41	Wahluke (near)	.56
West Virginia	38.5	−3.9	London	80	20	Alpena	−3	1	2.05	−1.88	Parsons	4.23	Dam 25 O. R	.58
Wisconsin	26.1	−3.1	Merrill	59	6	Long Lake	−30	10	.64	−1.10	Racine	2.66	2 stations	.05
Wyoming	28.8	−.9	Wheatland	73	6	Moran	−22	9	1.13	−.04	Bechler River	3.46	Lyman	.10
Alaska (February)	3.6	−4.9	Wrangell	51	25	Allakaket	−65	18	1.61	−.73	Baranof	15.05	Barrow	T
Hawaii	68.2	−.7	Lihue	87	[1] 24	Kanalohuluhulu	44	3	13.48	+5.05	Puohakamoa no. 2	56.20	Mahukona	.75
Puerto Rico	74.2	+.7	2 stations	94	[1] 15	Guineo Reservoir	36	6	1.29	−2.31	La Mina (El Yunque).	5.02	3 stations	.00

[1] Other dates also.

TABLE 2.—*Climatological data for Weather Bureau stations, March 1937*

District and station	Elevation of instruments: Barometer above sea level	Thermometer above ground	Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Departure from normal	Days with 0.01 inch or more	Wind: Average hourly velocity	Prevailing direction	Maximum velocity: Miles per hour	Direction	Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
New England							31.2	−1.5										68	3.34	−0.1										5.8		
Eastport	76	67	85	29.68	29.77	−0.16	28.6	−0.3	44	20	36	5	6	21	21	26	21	74	1.37	−2.5	9	12.1	nw.	42	e.	16	12	2	17	6.0	4.8	0.0
Greenville, Maine	1,070	6	40	-----	-----	-----	-----	-----	---	---	---	-----	---	---	---	---	---	---	-----	-----	---	-----	-----	---	-----	---	---	---	---	-----	-----	---
Portland, Maine	103	82	117	29.70	29.83	−.13	31.3	−.5	47	29	39	12	7	24	29	26	17	57	5.68	+1.8	13	9.5	w.	27	ne.	16	17	6	8	4.3	11.3	.0
Concord	289	60	----	29.52	29.84	−.16	29.2	−1.6	49	4	37	9	14	21	31	----	----	----	3.08	.0	9	------	nw.	----	-----	---	12	8	11	----	19.2	----
Burlington	403	11	48	29.43	29.89	−.11	23.8	−5.3	42	20	31	4	7	17	27	21	17	77	2.69	+.6	12	8.4	nw.	31	s.	8	6	5	20	7.1	26.3	5.1
Northfield	876	12	60	28.91	29.87	−.13	22.4	−4.0	43	20	32	−3	12	13	37	20	15	77	1.79	−.8	16	7.5	n.	24	ne.	24	6	7	18	7.0	18.8	4.5
Boston [1]	29	31	50	29.81	29.84	−.13	34.1	−1.5	57	4	42	15	7	26	27	29	21	61	3.57	.0	9	12.8	w.	35	ne.	15	10	9	12	5.6	1.9	.0
Nantucket	12	14	90	29.83	29.84	−.14	36.2	+.7	50	16	42	20	7	30	19	32	27	71	3.03	−.7	14	15.5	w.	38	sw.	17	11	3	17	6.5	1.0	.0
Block Island	26	11	46	29.83	29.86	−.12	35.2	−.2	51	16	40	19	7	30	19	32	28	77	3.55	−.3	16	19.5	nw.	43	se.	20	7	13	11	6.0	6.4	.0
Providence	160	215	251	29.69	29.86	−.12	34.6	−1.1	57	4	43	16	7	26	27	29	21	61	3.82	+.3	11	13.5	nw.	40	nw.	22	14	8	9	4.7	4.1	.0
Hartford	159	70	104	29.72	29.90	−.09	33.4	−1.6	56	4	40	16	7	26	26	----	----	----	3.78	−.1	10	10.0	nw.	31	nw.	21	12	6	13	5.4	5.0	.0
New Haven	106	74	153	29.78	29.90	−.09	34.5	−1.3	57	4	41	18	7	28	22	29	20	57	4.33	+.2	11	10.0	nw.	30	ne.	15	9	9	13	5.4	2.0	.0
Middle Atlantic States							38.9	−1.8										63	2.24	−1.2										5.4		
Albany	97	97	112	29.81	29.92	−.09	31.4	−1.3	58	4	38	14	7	24	31	26	18	60	2.40	−.2	12	8.0	nw.	24	s.	8	9	6	16	6.3	13.3	.0
Binghamton	871	57	79	28.99	29.95	−.07	29.0	−3.6	54	4	36	6	1	22	35	----	----	----	2.50	−.1	17	8.1	nw.	26	sw.	4	8	1	22	7.2	14.1	.0
New York	314	415	454	29.57	29.92	−.08	36.6	−1.1	60	4	43	19	10	30	25	30	22	59	2.98	−.7	15	18.3	nw.	50	nw.	26	9	11	11	5.6	1.9	.0
Harrisburg	374	94	104	29.55	29.96	−.07	37.6	−1.3	62	4	44	18	10	31	27	32	23	59	1.45	−1.6	8	9.5	nw.	28	nw.	16	10	10	11	5.8	9.5	.0
Philadelphia	114	174	367	29.83	29.96	−.06	38.7	−2.1	61	4	45	21	10	32	25	33	23	56	2.98	−.4	13	13.3	nw.	31	nw.	26	11	10	10	5.7	7.8	.0
Reading	323	283	306	29.60	29.96	------	37.4	−2.6	64	4	44	20	10	31	27	32	23	59	2.43	−1.1	12	13.7	nw.	35	nw.	29	9	14	8	5.5	11.1	.0
Scranton	805	72	104	29.04	29.94	−.08	31.4	−4.3	54	4	38	12	1	24	28	28	21	67	2.18	−1.0	13	7.9	nw.	22	nw.	28	8	7	16	6.4	9.1	.0
Atlantic City	52	37	172	29.88	29.94	−.08	40.0	+1.4	58	6	47	21	1	33	24	34	27	65	3.00	−.6	9	16.7	w.	40	w.	19	10	8	13	5.7	.1	.0
Sandy Hook	22	10	57	29.89	29.91	------	37.0	−2.3	58	4	42	22	10	32	23	33	28	72	2.41	−1.6	12	17.0	nw.	43	nw.	26	12	7	12	5.4	2.6	.0
Trenton	190	88	106	29.73	29.94	------	36.8	−2.3	62	4	44	20	10	30	30	32	24	62	1.97	−1.4	11	11.4	nw.	28	nw.	28	12	9	10	5.4	4.2	.0
Baltimore	123	100	215	29.84	29.97	−.06	41.9	−.4	67	4	50	23	10	34	31	35	26	58	1.93	−1.8	8	11.6	sw.	36	sw.	17	14	9	8	4.6	14.3	.0
Washington	112	62	85	29.85	29.98	−.06	42.0	−.6	70	25	51	19	1	33	31	35	27	59	1.50	−2.2	8	9.1	nw.	30	nw.	26	11	12	8	5.1	11.0	.0
Cape Henry	18	8	54	29.95	29.97	------	45.2	−1.4	76	25	52	27	2	38	32	40	35	73	3.23	−.6	9	13.0	n.	38	nw.	16	14	9	8	4.7	.0	.0
Lynchburg	686	148	184	29.25	30.00	−.05	45.2	−2.1	70	25	55	18	1	35	34	38	32	66	1.63	−1.9	6	9.3	nw.	32	nw.	16	16	9	6	4.2	3.0	.0
Norfolk	91	80	125	29.89	29.99	−.04	46.5	−1.7	76	25	55	24	1	38	28	40	34	68	3.08	−.7	8	10.5	w.	32	w.	16	14	4	13	4.9	T	.0
Richmond	144	11	52	29.83	29.99	−.05	44.7	−2.5	75	25	55	16	1	34	37	37	30	63	1.66	−2.0	6	8.9	nw.	34	w.	25	13	12	6	4.3	1.6	.0
Wytheville	2,304	49	55	------	30.00	−.05	40.3	−2.0	68	20	50	13	1	30	35	----	----	67	.76	−2.7	8	8.8	w.	28	w.	25	9	12	10	----	1.1	.0

TABLE 2.—*Climatological data for Weather Bureau stations, March 1937*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
South Atlantic States							53.0	−0.7										68	2.11	−1.6										4.4		
Asheville	2,253	89	104	27.63	30.03	−0.03	44.4	−.5	74	20	56	20	1	33	38	36	29	63	.74	−3.2	9	10.3	nw.	27	nw.	9	11	10	10	5.2	0.6	0.0
Charlotte	779	63	86	29.16	30.01	−.04	50.4	.0	73	23	61	24	1	39	32	42	33	58	2.13	−2.0	8	8.1	sw.	25	sw.	20	19	3	9	3.8	T	.0
Greensboro [1]	886	6	56	29.03	30.00		45.1		71	23	58	11	1	32	39	38	32	69	1.51		8	9.3	nw.	25	nw.	16	19	3	9	3.8	1.7	.0
Hatteras	11	5	50		29.98	−.06	50.0	−2.0	72	24	56	31	1	44	20			78	3.08	−1.2	8	14.1	n.	38	n.	31	14	9	8		.0	.0
Raleigh	376	103	146	29.58	29.99	−.06	49.4	−.8	77	25	60	20	1	39	37	43	30	72	1.93	−1.9	8	10.1	nw.	27	nw.	16	17	6	8	3.8	T	.0
Wilmington	72	73	107	29.93	30.00	−.05	53.2	−.1	78	25	63	25	1	43	30	46	41	70	1.87	−1.3	8	9.8	nw.	30	s.	24	17	9	5	4.0	T	.0
Charleston	48	11	92	29.97	30.02	−.04	57.0	−.4	79	19	66	31	1	48	27	49	44	70	1.84	−1.2	7	10.1	sw.	32	n.	15	15	6	10	4.7	.0	.0
Columbia, S C	347	70	91	29.64	30.03	−.03	54.2	−1.0	77	19	65	29	16	43	32	45	37	60	2.50	−.9	9	8.5	nw.	29	sw.	25	17	4	10	4.0	T	.0
Greenville, S. C	1,039	139					49.6	−.3	74	7	60	28	16	39	31				1.75	−3.4	7		ne.				14	8	9		.0	.0
Augusta	182	62	77	29.81	30.01	−.05	55.4	−.6	78	19	67	30	2	44	35	46	39	64	2.42	−1.7	9	6.2	nw.	19	w.	25	13	6	12	4.8	.0	.0
Savannah	65	73	152	29.96	30.02	−.04	59.0	.0	80	19	69	31	2	49	30	50	45	70	2.50	−.6	7	10.6	nw.	30	nw.	15	10	10	11	5.0	.0	.0
Jacksonville	43	86	110	29.99	30.04	−.02	60.8	−1.8	86	20	70	35	2	51	28	52	47	72	2.49	−.4	7	7.6	nw.	30	nw.	24	8	14	9	5.3	.0	.0
Florida Peninsula							67.8	−1.0										78	3.88	+1.7										5.0		
Key West	22	10	64	29.96	29.98	−.07	72.9	+.3	88	26	79	58	2	67	17	67	65	82	1.18	−.2	8	9.7	ne.	36	w.	31	14	10	7	4.5	.0	.0
Miami	25	124	168	29.97	30.00	−.08	70.4	+.2	87	27	77	48	2	64	23	64	61	78	7.06	+4.9	12	10.2	se.	37	sw.	8	11	11	9	5.4	.0	.0
Tampa	35	88	197	29.99	30.03	−.04	64.7	−2.1	85	22	74	40	2	56	28	57	53	75	2.83	+.4	6	11.0	n.	30	e.	30	13	10	8	5.0	.0	.0
Titusville	43	5	36	29.96	30.01		63.4	−2.4	88	25	75	37	2	52	32	56	54		4.47	+1.6	8		nw.				8	14	9		.0	.0
East Gulf States							54.9	−3.0										69	4.36	−0.8										5.2		
Atlanta [1]	976	5	53	28.99	30.03	−.03	50.5	−1.5	76	20	62	26	16	39	35	42	36	66	2.73	−2.6	9	10.3	nw.	34	nw.	15	12	7	12	5.2	.0	.0
Macon	370	79	87	29.62	30.04	−.02	54.4	−2.3	78	12	66	29	16	43	35	46	38	62	3.92	−1.0	9	6.9	nw.	21	nw.	15	12	10	9	4.8	.0	.0
Thomasville	273	49	58	29.75	30.05	−.01	57.9	−2.3	81	19	69	30	16	47	34	50	46		3.79	−.3	9		sw.				12	3	16		.0	.0
Apalachicola	35	11		30.01	30.05		58.2	−3.4	77	20	66	36	16	50	24	53	50	78	4.21	.0	6	8.2	n.	29	se.	30	7	12	12	5.7	.0	.0
Pensacola	56	149	185	30.00	30.06	.00	56.9	−3.4	76	25	64	32	16	49	24	53	51	84	4.30	−.5	11	11.6	n.	35	s.	19	13	11	7	4.6	.0	.0
Anniston	741	9					51.8	−.7	79	20	63	22	16	40	35				3.62	−2.0	9		nw.				12	12	7		.0	.0
Birmingham	700	11	48	29.28	30.06	.00	52.0	−3.4	77	23	63	26	16	41	32	44	36	62	3.70	−2.0	7	7.8	n.	23	w.	20	12	15	4	4.5	.0	.0
Mobile	57	86	105	30.00	30.06	.00	56.5	−3.2	79	25	67	32	28	46	32	50	46	74	6.96	+1.0	10	10.2	s.	29	w.	15	9	11	11	5.6	.0	.0
Montgomery	218	92	105	29.81	30.07	+.01	55.3	−2.5	81	20	66	30	16	45	32	47	40	62	5.59	−.4	10	7.5	n.	19	nw.	15	8	11	12	5.5	.0	.0
Meridian	375	67	92	29.66	30.07	+.02	52.8	−4.3	81	23	64	28	1	41	37	45	38	66	2.61	−2.6	11	6.6	n.	21	sw.	24	14	5	12	4.8	.0	.0
Vicksburg	247	65	73	29.83	30.09	+.05	53.5	−5.0	80	23	62	29	1	45	28	46	39	64	5.37	−.2	13	7.6	n.	20	w.	20	8	8	15	5.9	.0	.0
New Orleans	53	76	84	30.02	30.07	+.03	58.7	−4.1	81	18	68	35	1	50	26	52	48	72	5.58	+.9	12	7.6	ne.	20	ne.	26	8	11	12	5.9	.0	.0
West Gulf States							54.7	−4.5										72	3.55	+0.6										6.3		
Shreveport	249	92	227	29.80	30.08	+.06	54.4	−3.9	78	12	63	33	15	46	27	47	41	68	5.26	+1.2	14	11.4	ne.	28	nw.	20	11	8	12	5.7	T	.0
Bentonville	1,303	12	38	28.72	30.11	+.10	44.3	−3.0	70	19	54	20	15	34	32				3.71	−.3	9	7.8	sw.	25	sw.	19	8	13	10		1.4	.0
Fort Smith	457	79	94	29.58	30.07	+.06	48.6	−4.0	75	19	58	26	28	40	35	42	34	61	2.37	−.6	10	8.9	e.	30	sw.	24	11	12	8	5.0	T	.0
Little Rock	357	94	102	29.71	30.10	+.07	48.8	−4.2	78	19	58	26	28	40	32	42	35	65	2.22	−2.4	9	8.8	ne.	30	sw.	24	9	8	14	5.7	1.2	.0
Austin	605	136	148	29.41	30.05		55.7	−5.0	84	19	65	29	1	46	36	49	43	67	3.64	+1.3	9	9.2	s.	31	nw.	23	8	14	9	5.6	.0	.0
Brownsville	57	88	96	29.91	29.97		63.8	−4.4	84	19	71	42	31	57	33	59	57	83	.69	−.6	11	11.0	se.	35	nw.	20	1	13	17	7.7	.0	.0
Corpus Christi	20	11	78	29.99	30.01	+.03	62.1	−2.9	86	19	68	40	15	56	26	57	54	80	2.05	+.4	6	12.7	n.	42	ne.	5	3	12	16	7.2	.0	.0
Dallas	512	220	227	29.51	30.07		51.2		74	19	59	28	28	43	28	45	39	69	4.51	+1.6	8	13.5	n.	37	sw.	19	10	7	14	5.6	.8	.0
Fort Worth	679	92	110	29.36	30.08	+.10	51.6	−6.1	76	19	61	28	28	43	34				3.88	+1.6	10	11.1	n.	31	w.	19	13	6	12	5.3	2.0	.0
Galveston	54	106	114	29.99	30.06	+.05	58.4	−4.0	75	25	63	40	15	54	23	55	52	83	3.32	+.6	10	11.7	n.	35	nw.	24	7	6	18	7.2	.0	.0
Houston	138	292	314	29.91	30.06		57.8	−5.5	78	18	65	36	15	50	27				3.89	+.4	13	12.9	se.	30	se.	5	6	11	14	6.7	.0	.0
Palestine	510	64	72	29.54	30.08	+.08	53.0	−6.1	77	19	62	30	1	44	31	47	42	71	4.92	+1.4	13	8.7	n.	21	s.	23	12	4	15	5.9	.5	.0
Port Arthur	34	98	106	30.02	30.06		56.8		77	18	64	35	31	50	27				7.08	+3.8	12	11.4	se.	31	nw.	24	5	13	13	6.6	.0	.0
San Antonio	693	242	301	29.30	30.02	+.04	58.0	−4.8	85	19	67	32	15	49	33	51	44	68	2.10	+.3	9	12.5	ne.	32	sw.	23	3	12	16	7.1	.0	.0
Ohio Valley and Tennessee							40.9	−3.3										68	1.70	−2.5										5.9		
Chattanooga	762	71	214	29.23	30.06	.00	50.2	−1.0	76	13	61	25	2	39	32	42	34	60	2.92	−2.9	11	8.3	nw.	33	sw.	20	10	15	6	5.0	.9	.0
Knoxville	995	66	84	28.98	30.05	−.01	47.4	−1.3	76	20	58	26	2	37	35	40	33	64	1.61	−3.4	9	6.6	w.	22	w.	20	15	7	9	4.7	.9	.0
Memphis	399	78	86	29.65	30.08	+.04	47.8	−4.5	76	23	56	27	15	40	26	41	34	63	1.96	−3.3	9	9.2	n.	24	w.	23	9	9	13	5.6	T	.0
Nashville	546	168	188	29.50	30.10	+.05	45.8	−3.4	73	23	56	25	2	36	37	39	33	67	1.57	−3.5	8	10.0	nw.	38	se.	24	8	12	11	5.7	.3	.0
Lexington	989	6					39.5	−4.2	70	7	50	17	1	29	33				1.59	−2.7	9		n.				12	10	9		1.0	.0
Louisville	525	188	234	29.51	30.10	+.05	41.6	−3.8	70	24	50	21	11	33	28	36	30	69	.76	−3.6	7	11.0	n.	39	sw.	25	12	10	9	5.4	38	.0
Evansville	431	76	116	29.62	30.10	+.06	42.7	−3.2	70	24	51	23	15	34	28	36	29	62	.62	−3.6	7	9.7	n.	35	sw.	24	2	18	11	6.7	1.0	.0
Indianapolis	822	194	230	29.18	30.09	+.05	37.0	−3.0	67	7	45	17	11	29	30	32	26	69	1.47	−2.5	11	11.3	nw.	36	w.	20	6	9	16	6.7	4.7	.0
Terre Haute	575	63	149	29.45	30.08		39.4		70	6	48	15	11	30	30	34	28	69	1.78	−2.0	11	10.1	n.	26	nw.	8	7	14	10	6.1	8.1	.0
Cincinnati	627	11	51	29.39	30.09	+.04	38.3	−2.6	70	6	48	16	11	29	34	33	29	73	1.06	−2.8	7	8.6	nw.	28	sw.	20	8	9	14	6.4	13.0	.0
Columbus	822	90	210	29.16	30.06	+.02	36.6	−2.5	66	20	45	15	10	28	29	32	27	72	1.56	−1.9	10	9.8	n.	45	sw.	20	9	10	12	5.8	2.3	.0
Dayton	900	58	153	29.07	30.05		37.2	−3.3	66	24	46	14	11	29	31				1.60	−2.1	8	9.1	nw.	34	w.	20	7	12	12	6.1	4.8	.0
Elkins	1,947	59	78	27.94	30.06	+.01	35.2	−4.8	70	20	44	8	1	26	35	30	25	73	3.51	−.3	16	7.9	w.	29	w.	25	6	11	14	6.8	11.9	.0
Parkersburg	637	77	84	29.41	30.08	+.03	39.1	−3.7	73	20	48	17	10	30	31	34	29	74	1.36	−2.1	10	7.4	nw.	28	sw.	25	10	7	14	5.9	11.6	.0
Pittsburgh [1]	1,271	39	54	28.60	29.99	−.05	34.4	−5.2	62	20	42	9	10	26	27	30	24	72	2.09	−.9	12	12.9	nw.	41	sw.	20	8	9	14	6.2	8.4	.0
Lower Lake Region							29.6	−3.2										75	1.93	−0.7										6.6		
Buffalo	768	243	280	29.12	29.98	−.04	27.8	−3.3	44	4	33	12	9	23	22	25	22	80	1.81	−.8	17	17.3	w.	45	w.	17	6	6	19	7.1	14.6	T
Canton	448	10	61	29.42	29.92		22.8	−4.9	40	20	30	−6	3	15	32	21	18	82	2.22	−.3	15	9.6	w.	29	e.	25	6	8	17	6.5	21.8	3.0
Ithaca	836	77	100	29.02	29.95		28.6	−3.2	52	4	36	8	11	21	31	25	20	71	1.71	−.6	14	10.4	nw.	28	se.	20	7	3	21	7.2	~~18.4~~	.0
Oswego	335	71	85	29.57	29.95	−.06	27.9	−3.3	42	4	33	10	14	22	25	25	20	73	3.62	+1.0	19	11.8	w.	29	w.	17	6	5	20	7.3	33.5	T
Rochester	523	86	102	29.39	29.98	−.04	28.4	−3.4	45	4	34	12	10	23	19	25	21	74	2.83	+.1	17	10.5	w.	31	w.	17	6	8	17	6.7	30.0	1.5
Syracuse	596	65	79	29.28	29.95	−.07	28.6	−3.0	44	8	34	9	7	23	28				2.68	−.3	18	8.7	w.	21	nw.	21	5	7	19	7.4	25.0	T
Erie	714	130	166	29.22	30.01	−.01	30.4	−3.1	49	4	36	14	11	25	26	27	22	74	1.23	−1.4	14	13.6	w.	35	w.	17	9	4	18	6.6	5.4	.0
Cleveland	762	267	318	29.18	30.03	.00	31.7	−2.9	52	3	37	12	10	26	22	28	24	76	2.00	−.7	17	15.6	nw.	41	nw.	24	8	6	17	6.7	9.7	.0
Sandusky	629	5	67	29.34	30.05	+.02	33.2	−1.9	55	6	39	13	10	27	21				1.82	−.9	10	10.4	nw.	23	ne.	24	6	10	15	6.2	2.0	.0
Toledo	628	79	87	29.37	30.07	+.04	32.0	−3.3	56	6	39	12	26	26	25	28	23	71	1.22	−1.3	8	10.7	nw.	27	e.	24	8	12	11	5.8	4.5	.0
Fort Wayne	857	69	84	29.13	30.08		33.0	−3.8	59	6	40	13	9	26	27	29	25	75	1.42	−1.8	8	9.7	nw.	21	nw.	16	6	12	13	6.2	.8	.0
Detroit [1]	626	5	78	29.34	30.05	+.02	31.0	−2.4	54	6	38	11	26	24	24	27	21	71	.59	−1.8	7	11.4	nw.	25	sw.	1	12	7	12	5.7	2.8	.0

[1] Observations taken at airport.

TABLE 2.—*Climatological data for Weather Bureau stations, March 1937*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature: Departure from normal	Temperature: Maximum	Temperature: Date	Temperature: Mean maximum	Temperature: Minimum	Temperature: Date	Temperature: Mean minimum	Temperature: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Upper Lake Region							**26.8**	**−1.3**										**74**	**0.71**	**−1.3**										**5.6**		
Alpena	600	13	89	29.37	30.06	+0.03	25.4	−.1	42	21	32	2	9	18	23	22	17	72	.24	−1.8	9	12.1	nw.	29	nw.	17	7	11	13	6.0	7.6	0.0
Escanaba	612	41	49	29.43	30.13	+.09	24.2	.0	42	18	32	−2	10	16	30	21	15	70	.11	.0	5	8.8	n.	23	ne.	24	10	13	8	5.1	1.4	T
Grand Rapids	707	70	244	29.29	30.08	+.05	31.2	−2.2	58	6	38	11	9	24	25	27	22	73	1.10	−1.4	8	11.6	n.	34	ne.	24	9	8	14	6.0	3.9	.0
Lansing	878	5	90	29.09	30.06	------	29.4	−2.8	55	6	37	9	26	22	24	26	23	82	1.17	−1.2	9	10.0	nw.	23	w.	18	9	7	15	6.1	7.5	.0
Ludington	637	5	54																													
Marquette	734	77	111	29.29	30.12	+.08	23.0	−1.8	47	5	30	1	9	16	30	21	18	82	.44	−1.8	10	9.5	nw.	23	nw.	8	10	9	12	5.7	4.7	T
Sault Sainte Marie	614	11	52	29.38	30.11	+.08	21.2	−.4	37	31	29	−4	9	14	37	19	14	74	.24	−1.6	8	9.7	nw.	32	nw.	21	9	12	10	5.2	3.3	.2
Chicago	673	7	131	29.36	30.11	+.08	32.8	−2.5	58	3	38	14	9	28	27	29	24	72	1.20	−1.4	7	10.9	nw.	30	ne.	25	8	8	15	6.3	4.8	.0
Green Bay	617	109	141	29.41	30.10	+.06	27.8	−.8	47	29	35	2	9	20	24	24	18	70	.44	−1.6	3	11.1	n.	38	ne.	24	13	10	8	4.9	4.2	.0
Milwaukee	681	97	221	29.34	30.10	+.07	31.2	−.9	51	6	37	9	9	25	21	28	22	70	1.74	−.7	8	12.9	n.	34	ne.	25	8	8	15	6.0	13.2	T
Duluth	1,133	5	47	28.87	30.15	+.09	22.3	−1.4	48	5	31	−8	9	14	27	19	15	77	.40	−1.1	5	12.0	nw.	40	ne.	24	14	8	9	4.7	3.8	T
North Dakota							**24.1**	**+1.7**										**77**	**0.29**	**−0.5**										**5.7**		
Moorhead, Minn	940	50	58	29.15	30.21	+.13	22.4	−.3	46	5	30	−4	9	15	30	21	17	81	.30	−.7	4	8.4	n.	25	ne.	24	4	14	13	7.0	2.1	.3
Bismarck	1,674	8	57	28.33	30.18	+.12	28.6	+4.4	66	6	37	4	25	20	33	26	21	73	.58	−.3	4	8.7	ne.	30	ne.	23	8	14	9	5.7	7.1	T
Devils Lake	1,478	11	44	28.57	30.21	+.16	21.8	+2.0	50	5	31	1	13	13	26	20	18	84	.15	−.6	7	9.3	ne.	27	ne.	23	5	14	12	6.4	1.8	T
Grand Forks	833	12	67	------	------	------	20.2	−2.2	45	5	29	−5	10	11	35	19	------	------	.29	−.4	3	------	nw.	27	nw.	7	5	17	9	------	3.2	1.6
Williston	1,878	42	50	28.14	30.19	+.15	27.4	+4.5	59	6	37	3	25	18	29	24	18	69	.15	−.5	1	8.4	se.	24	s.	15	16	10	5	3.7	1.6	.0
Upper Mississippi Valley							**34.6**	**−1.7**										**72**	**1.39**	**−0.9**										**5.9**		
Minneapolis	919	105	208	29.14	30.15	------	27.0	−2.6	56	5	34	0	9	20	24	24	19	72	1.07	−.4	6	10.4	nw.	35	e.	24	11	10	10	5.6	8.2	.4
La Crosse	714	11	48	29.34	30.14	+.10	29.6	−1.9	55	6	38	4	26	21	29	26	22	76	.87	−.7	7	5.8	nw.	17	nw.	8	13	7	11	4.8	6.8	.0
Madison	974	70	78	29.03	30.12	+.08	28.8	−1.8	53	6	35	5	9	22	21	26	21	75	1.60	−.5	10	8.6	nw.	39	n.	24	10	7	14	5.8	9.9	T
Charles City	1,015	10	51	29.03	30.16	+.11	30.0	−.7	59	6	38	6	9	22	28	26	22	77	1.63	−.1	8	6.9	n.	31	ne.	24	11	11	9	5.0	7.2	.0
Davenport	606	66	161	29.45	30.13	+.10	35.0	−1.1	64	6	42	15	9	28	26	31	25	71	2.06	−.2	10	10.0	ne.	30	ne.	24	9	7	15	5.9	7.7	T
Des Moines	861	5	99	29.20	30.14	+.10	34.2	−1.7	68	6	42	14	25	27	31	31	27	78	1.99	+.2	10	9.9	n.	32	se.	24	7	6	18	6.7	5.4	.0
Dubuque	699	60	79	29.36	30.14	+.10	31.8	−2.2	60	6	39	9	9	25	24	28	23	72	1.84	−.2	9	6.5	nw.	24	e.	24	11	5	15	5.6	4.7	T
Keokuk	614	64	78	29.45	30.13	+.10	37.3	−1.6	69	6	46	18	26	29	35	32	26	67	.81	−1.6	9	8.3	sw.	23	n.	25	7	8	16	6.5	.8	.0
Cairo	358	87	93	29.70	30.10	+.06	44.8	−2.4	71	23	53	25	15	36	28	39	34	72	1.36	−2.4	5	10.7	n.	29	sw.	24	5	10	16	6.7	T	.0
Peoria	609	11	45	29.44	30.12	+.09	36.2	−.8	66	6	44	18	9	28	30	32	28	77	1.02	−1.7	7	7.8	nw.	20	ne.	24	9	14	8	5.3	1.2	.0
Springfield, Ill	636	5	191	29.41	30.11	+.08	39.0	−1.2	70	6	48	21	27	31	32	34	28	67	.69	−2.5	7	11.5	n.	28	e.	24	8	12	11	6.4	3.9	.0
St. Louis	568	179	303	29.48	30.10	+.07	41.4	−2.7	69	6	49	22	15	33	27	35	28	65	1.75	−1.6	7	11.5	nw.	32	sw.	24	8	10	13	6.0	7.7	.0
Missouri Valley							**36.6**	**−1.4**										**71**	**1.74**	**−0.2**										**6.3**		
Columbia, Mo	784	6	64	29.25	30.11	+.08	39.4	−3.2	68	7	48	14	15	30	29	------	------	------	2.07	−.9	9	8.6	n.	27	n.	25	9	8	14	5.9	12.8	.0
Kansas City [1]	750	32	45	29.28	30.11	+.09	39.8	−2.9	70	7	48	21	15	32	31	35	30	71	1.73	−.8	9	10.1	sw.	36	sw.	24	3	13	15	7.0	4.2	.0
St. Joseph	967	11	49	29.05	30.11	------	38.7	------	72	6	46	20	27	31	31	34	29	70	1.23	−1.2	10	9.0	nw.	27	n.	24	6	12	13	6.5	1.3	.0
Springfield, Mo	1,324	98	104	28.65	30.08	+.06	41.2	−4.0	70	19	50	20	15	33	27	35	29	66	1.80	−1.6	10	10.7	n.	38	sw.	24	8	12	11	5.2	1.4	.0
Topeka	987	65	87	29.02	30.10	------	39.4	−3.2	73	6	49	15	15	30	37	34	30	72	2.05	.0	7	9.7	n.	30	nw.	24	10	9	12	5.8	5.1	.0
Lincoln	1,189	11	81	28.81	30.11	+.09	36.6	−.9	73	6	46	14	15	28	36	32	26	69	2.38	+1.1	6	10.4	n.	33	n.	24	6	10	15	6.7	2.6	.0
Omaha [1]	982	31	44	29.05	30.13	+.09	35.4	−1.6	74	6	44	12	27	27	38	31	27	76	1.60	+.2	10	11.0	n.	38	e.	23	6	8	17	6.9	3.5	.0
Valentine	2,598	47	54	27.35	30.14	+.11	32.5	+.2	76	5	43	6	25	22	46	28	22	69	.64	−.4	6	9.3	w.	28	e.	23	6	9	16	6.7	3.7	.0
Sioux City	1,138	64	106	28.89	30.14	+.09	34.0	+1.3	73	5	43	11	27	25	39	30	26	76	2.50	+1.4	7	9.1	nw.	34	nw.	8	8	8	15	6.4	4.7	T
Huron	1,307	59	74	28.72	30.15	+.09	31.0	+2.1	68	5	39	8	26	23	34	27	22	73	1.45	+.5	5	10.2	ne.	41	ne.	24	9	12	10	5.6	5.4	.0
Northern Slope							**32.1**	**+0.3**										**70**	**1.18**	**+0.3**										**6.2**		
Havre	2,507	11	67	27.42	30.14	+.14	30.8	+3.7	56	5	40	4	26	21	31	27	22	72	.34	−.2	8	10.0	e.	29	se.	22	12	9	10	5.2	1.5	.0
Helena	4,124	85	111	25.80	30.10	+.09	32.2	−.2	55	9	41	8	26	24	30	28	22	67	.98	+.2	9	7.4	sw.	26	sw.	18	4	8	19	7.5	12.2	T
Missoula	3,263	80	91	------	------	------	37.4	+1.8	61	10	47	19	1	28	27	------	------	------	.52	−.5	8	8.9	e.	41	ne.	21	8	8	15	6.5	7.2	.0
Kalispell	2,973	48	56	26.94	30.06	+.07	33.8	+.9	50	10	43	14	1	25	26	30	25	71	.44	−.5	5	5.4	nw.	17	ne.	20	9	10	12	5.9	2.4	.0
Miles City	2,371	48	55	27.56	30.18	+.16	31.8	+3.2	65	5	42	−7	26	22	35	28	22	69	.66	−.2	5	6.6	ne.	25	nw.	6	6	14	11	5.9	7.0	T
Rapid City	3,259	50	58	26.66	30.19	+.18	30.9	−1.7	72	5	41	−5	26	20	40	27	22	72	1.63	+.7	6	8.1	n.	30	nw.	7	10	12	9	5.3	16.4	5.0
Cheyenne [1]	6,144	5	39	23.88	30.04	+.08	30.4	−2.7	64	6	42	2	15	19	42	26	19	68	2.09	+1.1	11	13.2	nw.	43	nw.	24	3	13	15	6.5	22.0	.0
Lander	5,372	60	68	24.61	30.07	+.08	31.4	−1.0	59	10	43	−2	26	20	37	27	20	64	1.43	+.2	7	4.6	sw.	23	nw.	31	12	7	12	5.6	13.5	T
Sheridan	3,790	10	47	26.11	30.13	------	29.2	------	56	9	41	−13	26	18	42	26	22	75	2.51	+1.4	10	5.7	nw.	25	se.	14	8	10	13	6.1	18.5	2.2
Yellowstone Park	6,241	12	46	23.82	30.13	+.11	27.1	−.1	55	5	38	−4	26	17	34	23	18	71	1.34	+.4	14	7.5	sw.	27	sw.	19	5	7	19	7.1	21.3	1.0
North Platte	2,821	11	51	27.09	30.09	+.09	35.4	−1.2	73	6	47	12	26	24	42	30	25	72	1.09	+.2	7	8.7	n.	32	n.	7	6	9	16	6.5	4.1	.0
Middle Slope							**40.3**	**−3.0**										**63**	**1.46**	**+0.2**										**5.8**		
Denver	5,292	106	113	24.67	30.01	+.06	37.3	−2.0	65	5	47	14	25	27	33	30	20	56	.69	−.4	10	8.6	s.	35	nw.	24	4	11	16	6.9	6.6	.0
Pueblo	4,685	80	86	25.24	29.99	+.07	38.8	−2.8	67	9	50	18	27	27	43	31	22	55	.77	+.2	8	8.2	e.	38	nw.	23	6	14	11	6.0	8.7	.0
Concordia	1,392	50	58	28.59	30.10	+.09	38.5	−2.5	69	6	47	15	15	30	29	34	29	74	2.21	+1.0	8	9.3	n.	27	nw.	24	9	8	14	6.1	.7	.0
Dodge City	2,509	10	86	27.42	30.07	+.10	40.2	−2.6	70	22	51	11	15	29	40	34	26	62	1.11	+.2	6	13.6	ne.	52	nw.	24	10	11	10	5.2	4.4	.0
Wichita	1,358	85	93	28.62	30.09	+.10	40.6	−4.5	69	7	50	14	15	31	32	35	29	67	2.80	+1.0	9	12.1	se.	35	sw.	24	10	9	12	5.5	4.9	.0
Oklahoma City	1,214	10	47	38.76	30.07	+.09	46.4	−3.6	75	11	57	21	15	36	33	39	32	64	1.15	−.8	6	11.2	n.	34	sw.	19	13	5	13	5.2	3.4	.0
Southern Slope							**50.4**	**−4.2**										**57**	**1.20**	**+0.3**										**5.4**		
Abilene	1,738	10	52	28.22	30.05	+.09	51.1	−5.4	82	23	62	25	27	40	36	43	34	61	1.34	.0	8	11.5	n.	36	sw.	17	9	10	12	5.5	.1	.0
Amarillo	3,676	10	49	26.26	30.04	+.09	44.2	−2.7	75	12	56	17	27	32	40	35	26	58	1.10	+.4	6	11.0	se.	37	w.	19	11	12	8	4.9	4.2	.0
Del Rio	960	63	71	28.98	29.98	+.03	59.4	−4.1	92	23	70	35	1	49	34	50	41	59	.92	+.2	8	10.4	se.	27	nw.	14	5	15	11	6.5	.0	.0
Roswell	3,566	75	85	26.35	29.99	+.09	46.8	−4.5	77	22	60	25	30	34	42	38	25	50	1.43	+.7	4	10.0	s.	38	nw.	19	13	11	7	4.7	T	.0
Southern Plateau							**48.6**	**−1.8**										**57**	**1.20**	**+0.4**										**3.9**		
El Paso	3,778	82	101	26.15	29.94	+.06	52.8	−3.0	80	22	66	32	15	40	39	41	28	44	.48	+.1	4	9.3	e.	29	sw.	18	20	6	5	3.2	.0	.0
Albuquerque [1]	4,972	5	39	24.99	29.93	------	43.4	−2.5	71	22	57	20	20	29	43	34	23	52	.63	+.2	7	11.2	n.	49	w.	18	9	15	7	5.3	4.4	.0
Santa Fe	7,013	38	53	23.15	29.95	+.06	37.7	−2.0	62	22	48	20	26	27	29	30	21	55	.69	−.1	7	7.2	n.	32	w.	18	10	10	11	5.8	7.8	.0
Flagstaff	6,907	10	59	23.26	29.88	−.03	34.2	−1.7	60	9	47	5	26	22	36	29	------	66	2.87	+.3	11	8.7	sw.	37	sw.	22	7	15	9	------	11.0	T
Phoenix	1,107	39	51	28.76	29.92	+.01	59.9	−.8	85	11	73	39	19	47	36	48	35	46	1.58	+.9	5	6.3	e.	34	w.	22	20	4	7	3.1	.0	.0
Yuma	141	9	54	29.78	29.93	−.01	63.3	−.8	90	10	78	42	27	49	41	50	34	40	1.47	+1.1	1	6.4	w.	29	nw.	22	21	6	4	2.3	.0	.0
Independence	3,957	5	26	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------

[1] Observations taken at airport.

TABLE 2.—*Climatological data for Weather Bureau stations, March 1937*—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch or more	Wind: Average hourly velocity	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Middle Plateau							41.7	+0.7										61	1.14	+0.2										5.5		
Reno	4,532	74	81	25.38	29.93	-0.05	43.3	+2.2	66	8	55	25	29	32	35	36	26	54	.06	-.8	4	7.6	w.	30	sw.	19	7	14	10	5.5	T	0.0
Tonopah	6,090	12	20				39.0		59	9	47	18	19	31	26	33	25	62	.90		8		se.									
Winnemucca	4,344	18	56	25.55	29.96	-.05	41.2	+1.2	63	11	53	21	5	29	37	36	29	65	1.28	+.3	9	8.7	ne.	22	s.	21	7	12	12	5.9	4.0	.0
Modena	5,473	10	43	24.54	29.91	-.05	38.8	+.6	64	11	51	10	19	26	37	33	26	66	2.56	+1.5	11	9.1	w.	34	sw.	22	12	3	16	5.6	15.8	.0
Salt Lake City [1]	4,360	32	46	25.68	29.97	-.01	41.0	-.7	61	11	52	17	19	30	30	35	29	65	1.18		9	9.1	se.	41	w.	23	9	8	14	5.6	5.5	.0
Grand Junction	4,227	60	68	25.32	29.91	-.03	44.0	+.4	66	11	55	25	4	33	32	35	25	53	.67	-.1	8	7.3	se.	30	s.	22	11	11	9	4.8	2.5	.0
Northern Plateau							42.9	+1.6										64	1.40	+0.2										6.7		
Baker	3,471	48	53	26.40	30.02	-.01	39.6	+2.0	56	11	49	21	7	30	31	35	29	69	1.23	+.1	11	6.3	se.	19	sw.	20	4	10	17	7.1	3.1	.0
Boise	2,739	79	87	27.14	30.02	-.01	44.4	+1.7	64	11	54	27	19	34	29	38	31	62	1.80	+.4	12	6.6	se.	26	se.	21	5	10	16	6.7	T	.0
Pocatello	4,477	60	68	25.43	30.01	.00	37.2	-.2	55	12	46	21	24	28	26	33	27	68	1.40	+.1	11	8.8	se.	34	sw.	18	11	6	14	6.0	5.4	.0
Spokane	1,929	101	110	27.93	30.01	.00	42.2	+2.5	59	11	51	27	7	34	31	37	29	61	1.11	-.1	8	7.1	e.	23	ne.	12	7	6	18	6.5	.6	.0
Walla Walla	991	57	65	28.90	29.97	-.05	47.5	+1.4	65	11	56	31	21	39	26	42	35	64	1.97	+.4	14	5.5	s.	21	w.	30	6	9	16	6.9	.0	.0
Yakima	1,076	58	67	28.82	29.98		46.3	+2.2	65	5	56	28	23	37	27	40	32	60	.91	+.5	9	5.8	nw.	22	ne.	13	4	9	18	7.1	.1	.0
North Pacific Coast Region							48.1	+2.6										74	3.15	-1.1										8.5		
North Head	211	11	56	29.73	29.96	-.05	47.4	+2.2	64	3	52	38	19	43	20	44	41	81	3.71	-1.8	19	14.4	e.	47	s.	4	2	3	26	8.5	.0	.0
Seattle	125	90	321	29.82	29.94	-.05	48.9	+4.0	70	8	56	36	23	42	28	44	39	70	2.28	-.8	19	8.7	se.	31	s.	31	0	15	16	7.7	.0	.0
Tatoosh Island	86	10	54	29.83	29.93	-.03	46.2	+3.3	62	4	50	38	18	42	17	44	40	81	4.00	-3.8	22	15.5	e.	50	e.	7	1	5	25	8.8	.0	.0
Medford [1]	1,329	29	58	28.54	29.96		47.6	+.7	75	7	58	30	3	37	43	42	36	70	2.48	+.8	14		nw.				1	8	22	8.4	T	.0
Portland, Oreg.	153	68	106	29.80	29.95	-.07	49.7	+2.8	66	4	56	36	18	43	24	45	39	70	2.81	-1.1	24	6.3	se.	21	sw.	29	0	8	23	8.6	.0	.0
Roseburg	510	45	76	29.41	29.97	-.07	50.0	+2.9	73	4	59	32	18	41	41	45	40	72	3.60	+.3	20	4.3	n.	23	sw.	18	1	4	26	8.8	.0	.0
Middle Pacific Coast Region							53.1	+0.4										73	7.42	3.5										7.0		
Eureka	62	73	89	29.93	30.00	-.06	50.1	+1.8	76	4	56	39	18	44	30	46	43	81	7.19	+2.0	21	7.6	se.	32	sw.	20	4	2	25	8.3	.0	.0
Redding [1]	722	20	34				52.0	-2.0	74	3	60	36	22	44	26	45	39	66	9.08	+4.4	16	8.1	nw.	34	se.	23	3	5	23	8.7	.0	.0
Sacramento	66	92	115	29.92	29.99	-.04	55.4	+1.1	76	5	64	39	18	47	27	49	44	68	6.37	+3.8	14	7.0	s.	25	se.	21	15	10	6	4.5	.0	.0
San Francisco	155	112	132	29.82	29.99	-.07	54.8	+.6	76	4	61	44	22	49	28	49	45	76	7.05	+3.9	13	7.6	w.	23	w.	18	8	10	13	6.3	.0	.0
South Pacific Coast Region							57.1	+0.7										67	3.00	+1.0										4.9		
Fresno	327	97	105	29.65	30.01	.00	56.3	+1.3	80	8	66	39	19	46	30	50	44	66	2.32	+.7	8	5.6	nw.	25	nw.	17	8	12	11	5.7	.0	.0
Los Angeles	338	159	191	29.62	29.99	-.03	58.5	+1.0	83	3	67	43	22	50	27	50	43	63	4.04	+1.3	6	6.5	sw.	19	s.	12	17	7	7	3.7	.0	.0
San Diego	87	62	70	29.90	29.99	-.03	56.6	-.1	77	3	64	44	7	49	30	51	46	72	2.65	+.9	11	7.4	w.	28	s.	12	13	7	11	5.3	.0	.0
West Indies																																
San Juan, P. R.	82	9	54	29.90	29.98		76.7	+1.3	90	15	82	66	6	71	17				.93	-2.2	8	11.2	e.	27	e.	4	13	16	2	4.1	.0	.0
Panama Canal																																
Balboa Heights	118	6	92		[3] 29.81	-.04	81.4	+.2	93	12	90	70	7	73	21			[3] 74	2.44	+1.7	1	9.1	nw.	27	n.	2	10	18	3	4.8	.0	.0
Cristobal	36	6	97		[3] 29.84	-.04	82.0	+.5	88	25	86	73	30	78	13	75	72	[3] 74	.32	-1.2	7	13.6	n.	26	n.	2	8	18	5	5.2	.0	.0
Alaska																																
Fairbanks	454	11	87	[3] 29.46	[3] 30.01		5.9	-3.6	46	16	21	-31	4	-9	45	6	-2	61	T	-.4	0	4.4	s.	19	s.	16	15	6	10	4.5	T	27.9
Juneau	80	96	116	[3] 29.74	[3] 29.83		38.0	+4.3	54	11	43	27	22	33	18	35	29	70	6.14	+.7	20	6.5	s.	24	e	6	4	2	25	8.4	14.8	.0
Nome	22	5	32	[3] 30.01	[3] 30.03		3.6	-.5	34	14	13	-30	9	-6	33	4	1	72	.40	-.5	6	5.7	ne.	25	ne.	25	20	3	8	3.5	4.8	42.0
Hawaiian Islands																																
Honolulu	38	86	100	[3] 29.95	[3] 29.99		70.9	-.5	80	27	75	63	2	67	11	65	62	73	1.69	-1.5	11	10.9	e.	30	ne.	7	7	9	15	6.4	.0	.0

[1] Observations taken at airport.
[2] Observations taken bihourly.
[3] Pressure not reduced to 24-hour mean.

TABLE 3.—*Data furnished by the Canadian Meteorological Service, March 1937*

Station	Altitude above mean sea level Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	*In.*	*In.*	*In.*
Cape Race, Newfoundland	99												
Sydney, Cape Brenton Island	48	29.63	29.68	−0.20	28.4	+2.2	35.2	21.6	47	4	3.44	−1.49	14.1
Halifax, Nova Scotia	88	29.48	29.59	−.35	29.4	+.4	35.2	23.5	47	11	3.07	−2.39	10.5
Yarmouth, Nova Scotia	65	29.64	29.71	−.24	31.8	+1.0	37.4	26.3	52	16	3.29	−1.71	5.5
Charlottetown, Prince Edward Island	38	29.63	29.67	−.23	25.7	+.3	32.4	18.9	42	4	2.36	−.85	19.7
Chatham, New Brunswick	28	29.60	29.63	−.27	23.7	+.7	33.1	14.2	44	−9	2.62	−.85	9.2
Father Point, Quebec	20	29.71	29.73	−.17	22.8	+2.5	28.4	17.3	40	8	1.07	−1.66	10.7
Quebec, Quebec	296	29.44	29.77	−.19	21.4	+.2	28.6	14.2	42	−3	2.07	−1.19	17.4
Doucet, Quebec	1,236				7.5		20.8	−5.9	30	−30	1.77		17.7
Montreal, Quebec	187												
Ottawa, Ontario	236	29.64	29.92	−.09	21.2	−.3	28.5	13.9	37	−12	1.47	−1.25	14.7
Kingston, Ontario	285	29.61	29.94	−.07	25.2	−.4	31.8	18.7	41	2	1.22	−1.42	7.3
Toronto, Ontario	379	29.56	29.99	−.03	28.6	+1.3	34.7	22.5	45	9	1.48	−1.16	9.1
Cochrane, Ontario	930				10.1		20.0	.2	32	−22	1.36		13.6
White River, Ontario	1,244	28.71	30.08	+.05	11.6	−.6	25.9	−2.6	40	−28	.76	−.62	7.6
London, Ontario	808				27.4		34.2	20.7	45	6	1.29		10.6
Southampton, Ontario	656	29.28	30.02	−.01	24.2	−.5	30.2	18.3	38	1	2.93	+.28	29.3
Parry Sound, Ontario	688	29.26	29.99	−.03	22.9	+1.8	30.8	15.0	39	−6	1.29	−.94	12.9
Port Arthur, Ontario	644	29.43	30.17	+.12	17.2	+.4	27.7	6.7	39	−10	.34	−.63	3.4
Winnipeg, Manitoba	760	29.36	30.24	+.15	17.1	+4.8	26.5	7.7	48	−21	.28	−.75	2.8
Minnedosa, Manitoba	1,690	28.32	30.22	+.16	17.5	+5.0	26.5	8.4	44	−12	.39	−.26	3.9
Le Pas, Manitoba	860				13.8		25.2	2.4	44	−14	1.27		12.7
Qu'Appelle, Saskatchewan	2,115	27.84	30.18	+.14	19.3	+4.4	29.3	9.3	47	−12	.14	−.63	1.4
Moose Jaw, Saskatchewan	1,759				23.6		34.9	12.4	53	−1	.18		1.8
Swift Current, Saskatchewan	2,392	27.52	30.14	+.12	25.8	+3.8	35.8	15.8	49	−10	.20	−.61	2.0
Medicine Hat, Alberta	2,365	27.57	30.13	+.13	27.9	+.4	36.9	18.9	52	−3	.89	+.13	8.9
Calgary, Alberta	3,540	26.34	30.14	+.19	26.2	.0	34.1	18.2	63	−8	1.66	+.94	16.6
Banff, Alberta	4,521												
Prince Albert, Saskatchewan	1,450	28.64	30.30	+.22	16.8	+4.8	28.4	5.3	52	−12	.27	−.50	2.7
Battleford, Saskatchewan	1,592	28.42	30.25	+.19	15.8	+2.7	28.2	3.5	47	−10	.01	−.45	.1
Edmonton, Alberta	2,150												
Kamloops, British Columbia	1,262	28.65	29.96	+.04	40.5	+4.4	49.7	31.3	61	20	.61	+.04	.6
Victoria, British Columbia	230	29.69	29.94	−.03	46.2	+4.3	51.7	40.6	61	36	1.35	−1.77	.0
Barkerville, British Columbia	4,180												
Estevan Point, British Columbia	20				44.9		51.0	38.8	58	30	13.11		.0
Prince Rupert, British Columbia	170				43.1		50.5	35.7	62	28	4.51		.0
St. George's, Bermuda	158		29.97	−.11	63.3	+.5	68.1	58.5	75	52	4.41	−.33	.0

LATE REPORTS FOR FEBRUARY 1937

Station	Altitude	Station pressure	Sea level pressure	Departure	Mean	Departure	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure	Total snowfall
Cape Race, Newfoundland	99				27.8		32.2	23.4	40	5	2.64		4.8
Sydney, Cape Breton Island	48	29.76	29.81	−0.11	25.2	+5.9	31.9	18.4	40	0	3.07	−1.02	15.3
Halifax, Nova Scotia	88	29.59	29.70	−.25	27.1	+4.7	32.9	21.3	48	5	4.06	−1.10	25.5
Yarmouth, Nova Scotia	65	29.75	29.82	−.17	30.6	+4.8	36.0	25.2	50	17	1.71	−2.46	3.1
Charlottetown, Prince Edward Island	38	29.82	29.86	−.09	21.9	+4.3	29.3	14.5	42	−8	3.00	−.06	22.9
Chatham, New Brunswick	28	29.78	29.82	−.14	19.3	+6.8	29.6	9.0	48	−16	2.74	−.42	19.4
Quebec, Quebec	296	29.54	29.87	−.12	20.5	+8.7	27.4	13.6	40	−2	2.42	−.85	11.9
Doucet, Quebec	1,236				10.6		24.4	−3.2	44	−42	1.56		10.4
Ottawa, Ontario	236	29.66	29.94	−.08	20.0	+8.3	27.9	12.2	41	−4	2.48	−.21	8.2
Cochrane, Ontario	930				10.6		20.4	.8	44	−22	1.52		10.6
Parry Sound, Ontario	688	29.21	29.94	−.07	22.3	+8.0	30.2	14.3	47	−2	5.00	+2.08	28.9
Port Arthur, Ontario	644	29.19	29.93	−.12	11.2	+4.8	21.2	1.3	39	−20	4.36	+3.46	43.6
Le Pas, Manitoba	860				−.4		9.9	−10.6	42	−33	.31		3.1
Medicine Hat, Alberta	2,365	27.41	30.02	−.03	6.1	−5.1	15.9	−3.7	40	−36	.53	−.14	5.3
Calgary, Alberta	3,540	26.14	30.00	+.01	10.7	−2.8	20.0	1.5	46	26	.22	−.41	2.2
Banff, Alberta	4,521	25.12	29.90	−.08	10.6	−8.6	21.5	−.2	40	−33	1.57	+.65	15.7
Prince Albert, Saskatchewan	1,450	28.38	30.05	−.04	.5	+3.5	11.4	−10.5	37	−38	.71	+.02	7.1
Edmonton, Alberta	2,150	27.56	29.97	−.05	6.6	−1.7	17.3	−4.0	45	−26	.23	−.44	2.3
Kamloops, British Columbia	1,262	28.62	29.96	.00	19.8	−8.5	26.8	12.7	44	−13	2.61	+1.82	23.8
Victoria, British Columbia	230	29.62	29.88	−.12	38.6	−.9	42.8	34.4	53	26	5.23	+1.13	13.1
Estevan Point, British Columbia	20				39.4		44.1	34.6	50	26	14.02		28.3
Prince Rupert, British Columbia	170				31.7		38.2	25.3	54	12	6.94		13.5

TABLE 4.—*Severe local storms, March 1937*

[Compiled by Mary O. Souder from reports by Weather Bureau officials]

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the United States Meteorological Yearbook]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Providence, R. I., and vicinity	6					Snow	Roads slippery; severe accidents reported throughout the city and State.
Colorado: South of Arkansas-Platte Divide.	7					Dust	Storm continued for about 10 hours, with visibility, at times, reduced to zero. Traffic at standstill and automobiles damaged by flying sand and gravel. Much soil erosion in Baca County.
Guthrie, Okla., vicinity of	12	7 p. m.	2,640		$3,500	Hail	Crop loss, $3,000; property damage, $500; path 8 miles long.
Lyon to Sedgwick Counties, Kans.	12-13					Sleet and heavy snow.	Highway traffic greatly retarded for a day or two.
Evansville, Ind	13	A. m.				Sleet, glaze, and snow.	Visibility reduced; streets slippery. Several accidents reported with 7 persons injured.
Harrisburg, Pa., and vicinity	14-17					Snow and wind	Heavy snow from the 14th to 16th with 8 inches recorded. Streets and highways icy; several accidents reported because of skidding. Winds during the night of 16-17th caused mush drifting in outlying districts with some highways and roads temporarily blocked.
Oswego, N. Y., and vicinity	15-17			1		do	Continuous snowfall and high winds. County road kept open with difficulty. A snowplow and locomotive derailed at the railroad crossing causing the death of a man and injury to another.
Yuma, Ariz., and vicinity	16				10,000	Heavy rain	1.47 inches, greatest 24-hour fall in March in the history of the station. Damage to the Yuma Canal and some flooding reported.
New York State, central and northern and portions of the western section.	16-17					Snow	Highways blocked and train service delayed because of drifts. Hundreds of automobiles and trucks stalled.
New York, N. Y.[1]	17					Wind	1 person injured.
Monticello Community, East Carroll Parish, La.	19	2:30 p. m.	250	0	4,000	Tornado	Storm struck a short distance west of the Monticello school. Tenant houses and timber blown down. 8 persons injured; path 3 miles long.
Evansville, Ind	20	5:30-11:15 a. m.				Dust	Visibility reduced to 1,320 yards.
Gaffney, S. C	20	6:20 p. m.	20	0	50,000	Tornado	Number of buildings wrecked and unroofed; telephone and power lines down; path 4 miles long.
York, S. C., 7 miles north	20	7:20 p. m.		0	5,000	do	A country residence and outbuildings wrecked.
Fort Wayne to Albion, Ind.,[1] and vicinities.	21	P. m.				Sleet and wind	Wires down because of heavy coating of ice and high wind.
Groton, S. Dak	23	8 a. m.				Rain, sleet, and wind.	This one of the most severe sleet storms ever reported in this vicinity. All exposed objects heavily ice-coated. All communication discontinued because of broken poles and wires. Many trees completely ruined.
Boulder, Colo	23	6-10 p. m.				Straight-line wind.	Trees broken; telephone and power lines damaged.
Denver, Colo.[1]	23	P. m.				Wind	A 2-story brick factory wrecked; electric lines snapped, stopping radio programs and car service; trees uprooted. No estimate of damage given.
Hope and Pike City, Ark., vicinity of.	23				4,000	Wind and hail	Houses, barns, and sheds unroofed. Loss to 100 acres of radishes in Hope.
Ness, Hodgeman, and Ford Counties, Kans.	23-24	P. m.			3,500	Wind	Some damage in Ness County. Considerable damage to outbuildings in Hodgeman County. In Dodge City damage to roofs, porches, and windows. Trees blown down. $3,500 damage in Hodgman and Ford Counties.
Minnesota, extreme southwestern counties.	23-24					Snow, sleet, and rain.	Snowfall unusually heavy; roads blocked; traffic seriously delayed; damage to wires and trees.
South Dakota, eastern portion	23-24			1	500,000	Rain, snow, and wind.	Wires and about 10,000 poles down. Some drifts 5 feet deep. Windows blown in and trees uprooted. In Kingsbury County a woman lost her way in the storm and froze to death.
Charles City, Iowa	24	8-10 a. m.				Wind and snow	Reduced visibility of 300 feet reported. Dust at noon and in the afternoon.
Ozark, Ala., vicinity of	24	10:45 a. m.	200	2	1,000	Tornado	Storm dipped into a rural community, killing 2 persons and demolishing their home. The bodies were found 250 yards from the wreckage.
Pueblo, Baca, and Powers Counties, Colo.	24					Dust	The region south of the Arkansas-Platte Divide in semidarkness during practically the entire day. The storm continued at Pueblo until 8 p. m. In Baca and portions of Powers Counties it was the worst and most damaging storm this season. For 84 consecutive hours, whirling clouds of silt continued in this region with visibility from zero to a few feet. Zero visibility during this entire time on the south side of plowed or cultivated fields during this period.
Minnesota,[1] southern portion	24					Snow and sleet	8 inches of wet snow covered this section, impeding highway travel, slowing rail transportation, and halting air service. Sleet, at some points, covered telegraph and telephone lines, breaking poles and wires.
Redfield, S. Dak., and vicinity	24					Rain and sleet	Communication lines in every direction disrupted. Many poles, wires, and trees down.
Fayette and Clark Counties, Ky.	25		100-200	5	150,000	Tornado	23 persons injured. Storm began at Athens and moved nearly east through the southern edge of Winchester to a point around 5 miles beyond. Path 15 miles long. About an hour after this storm, a violent wind wrecked several buildings at Victory, in Laurel County.
Burwood, La	26	1:45-2:15 p. m.				Thundersquall, heavy rain, and hail.	Wind reached an estimated velocity of 65 miles an hour. Some property damaged.

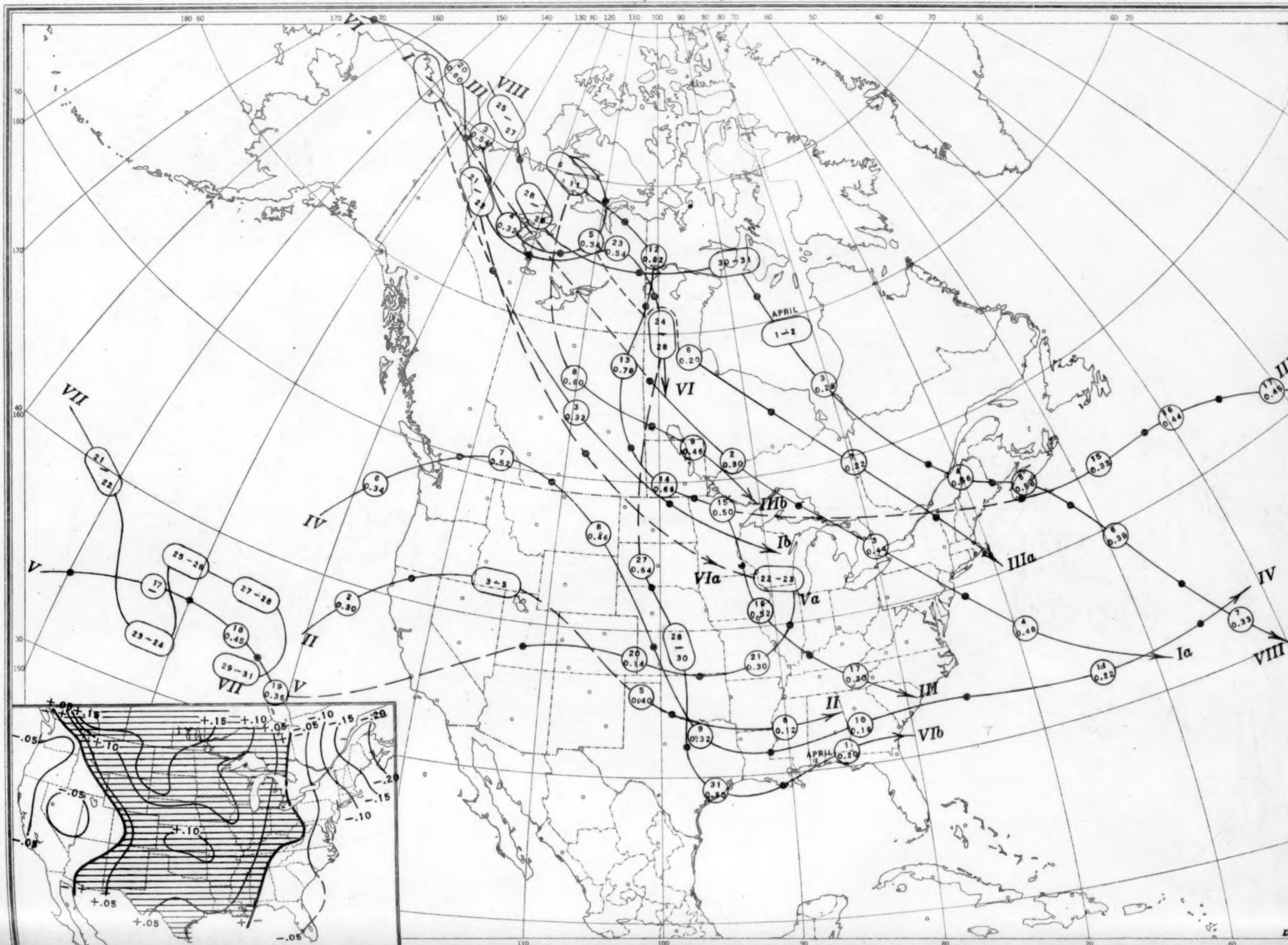
[1] From press reports.

Chart I. Departure (°F.) of the Mean Temperature from the Normal, March 1937

Chart I. Departure (°F.) of the Mean Temperature from the Normal, March 1937

Chart II. Tracks of Centers of Anticyclones, March 1937. (Inset) Departure of Monthly Mean Pressure from Normal

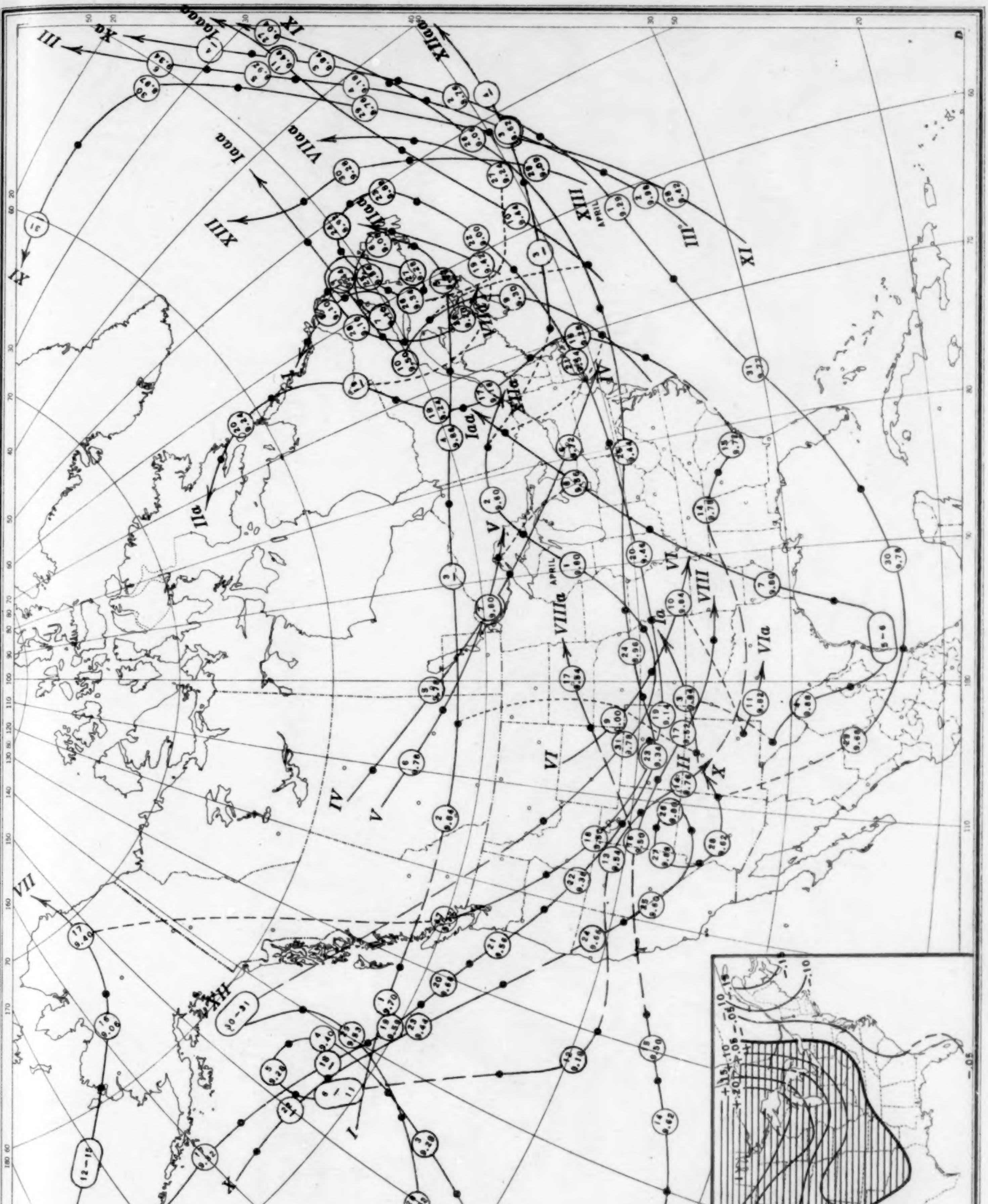
(Plotted by W. P. Day)



Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 7:30 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, March 1937. (Inset) Change in Mean Pressure from Preceding Month

Chart III. Tracks of Centers of Cyclones, March 1937. (Inset) Change in Mean Pressure from Preceding Month
(Plotted by W. P. Day)



Circle indicates position of cyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 7:30 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, March 1937

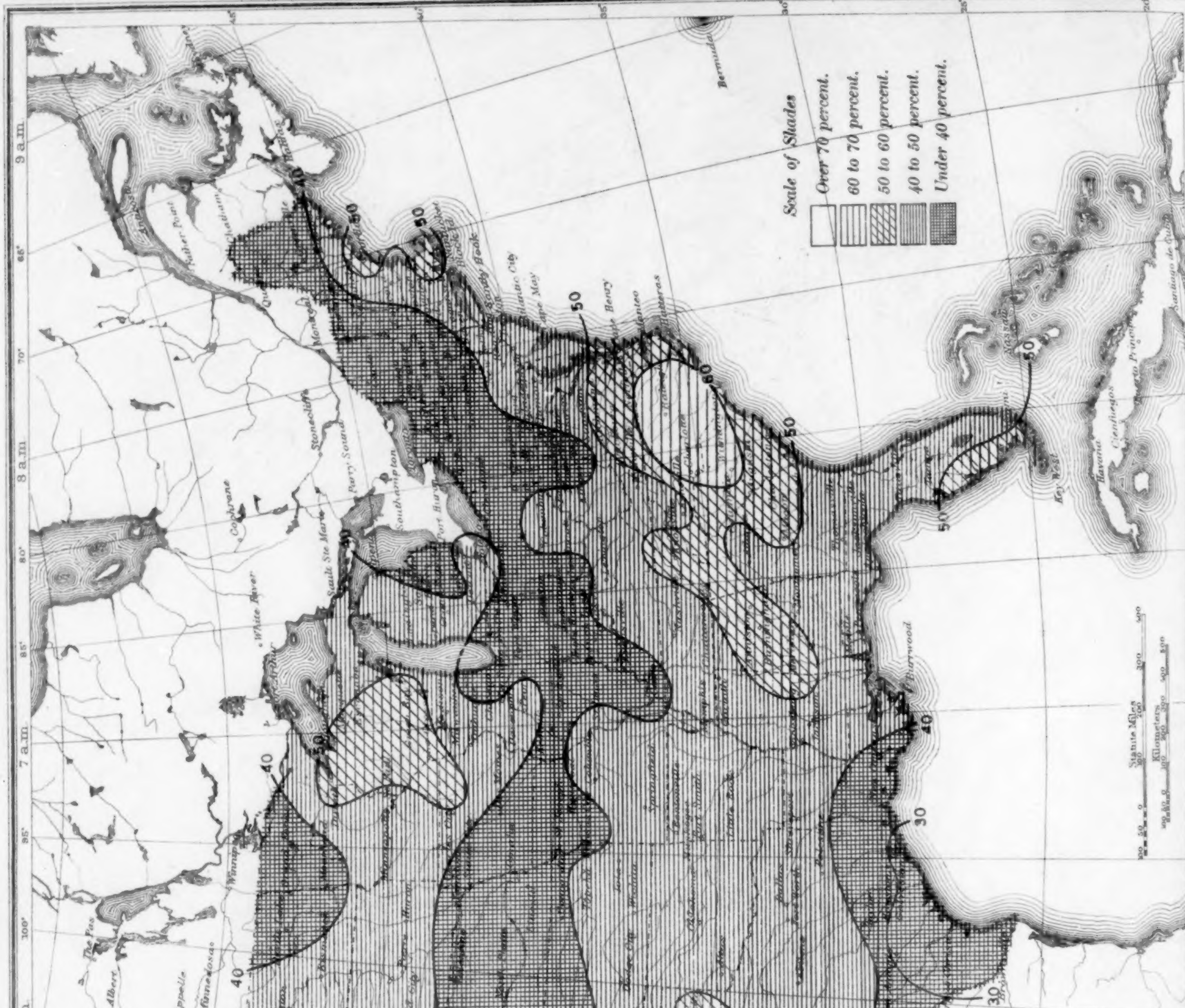


Chart V. Total Precipitation, Inches, March 1937. (Inset) Departure of Precipitation from Normal

Chart V. Total Precipitation, Inches, March 1937. (Inset) Departure of Precipitation from Normal

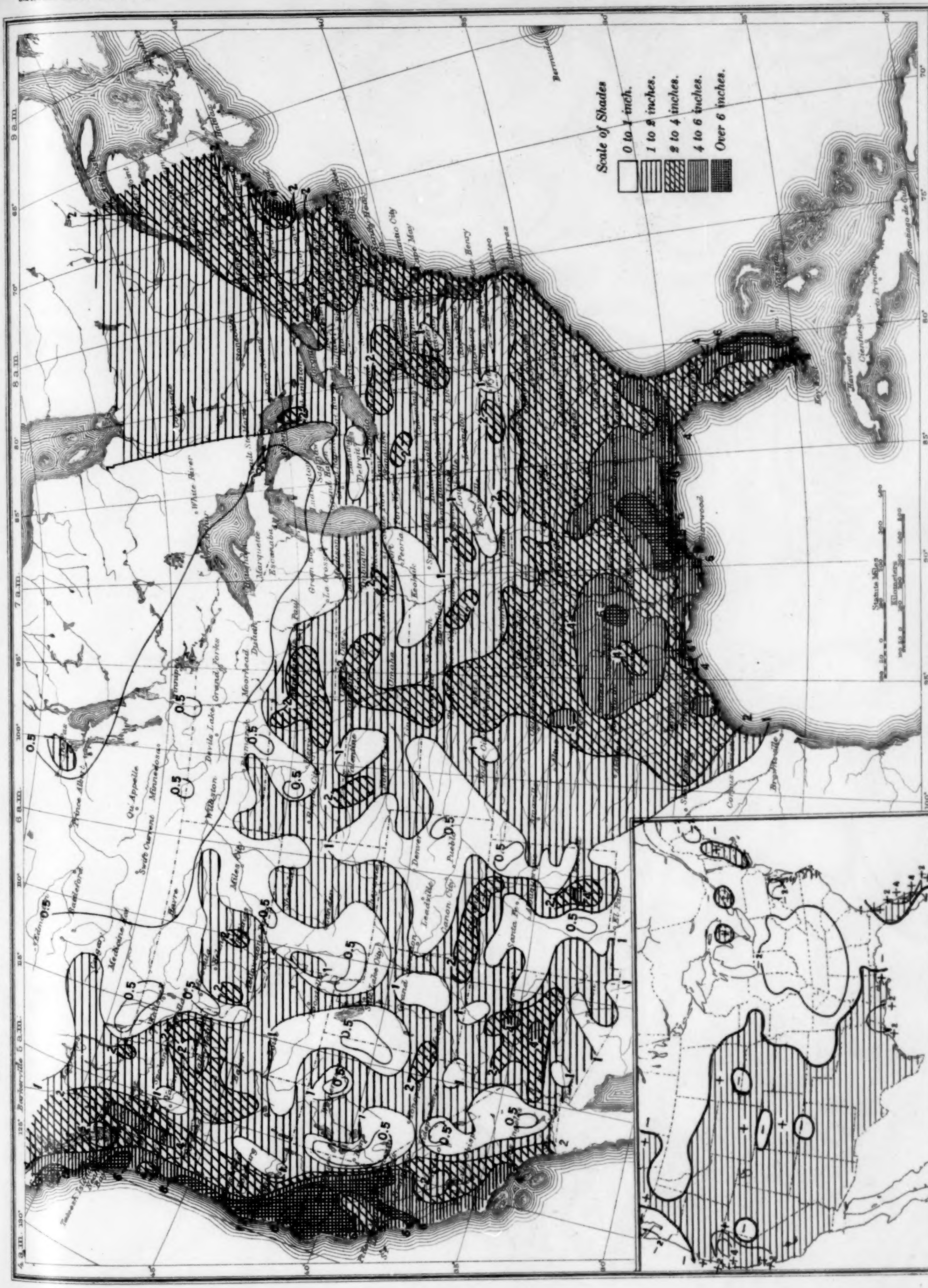


Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, March 1937

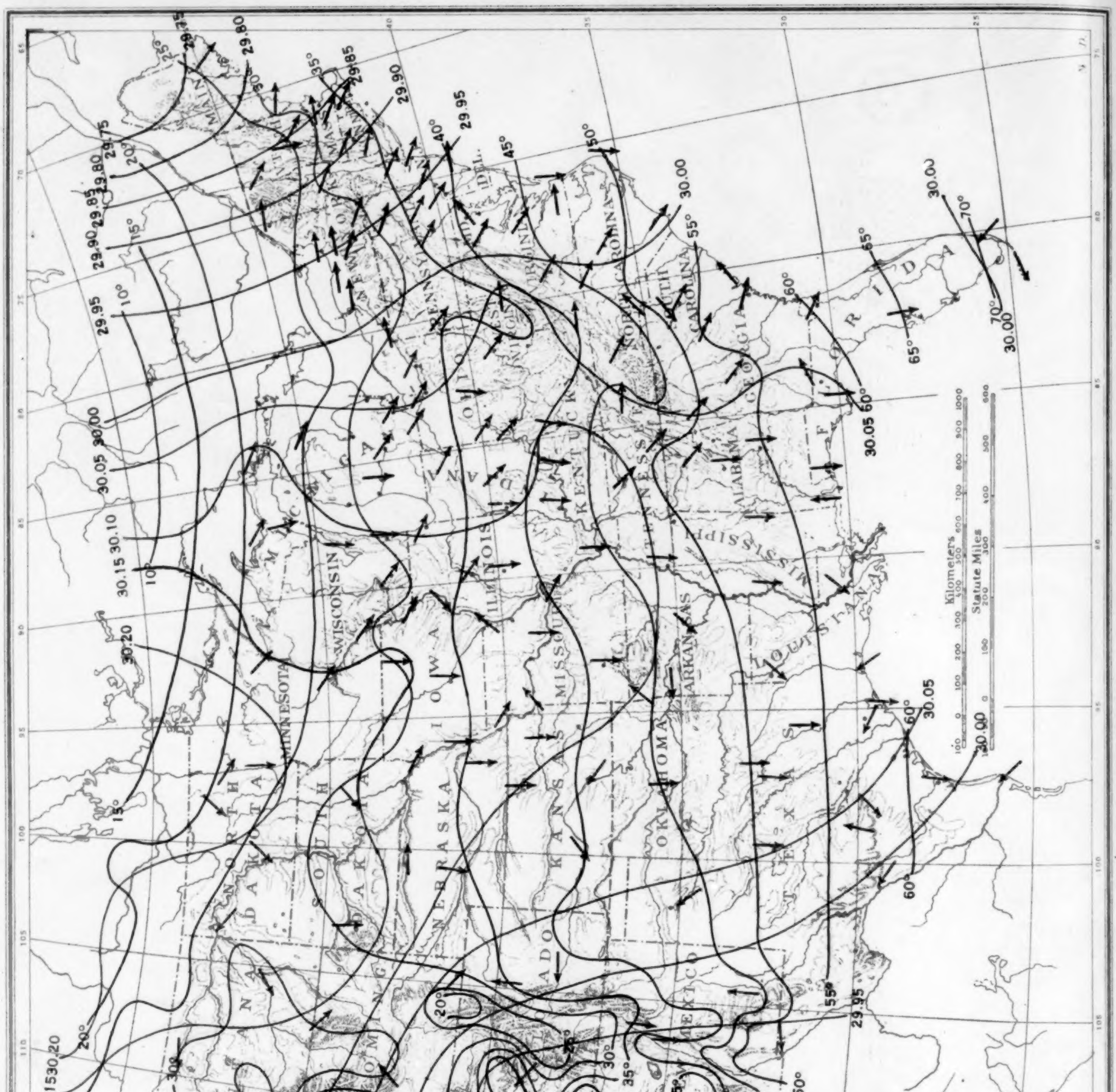


Chart VII. Wind Roses for Selected Stations, March 1937
(Plotted by W. W. Reed)

Chart VII. Wind Roses for Selected Stations, March 1937
(Plotted by W. W. Reed)

Chart VIII. Total Snowfall, Inches, March 1937. (Inset) Depth of Snow on Ground at 7:30 p. m., Monday, March 29, 1937

Chart IX. Weather Map of North Atlantic Ocean, March 16, 1937
(Plotted from the Weather Bureau Northern Hemisphere Chart)

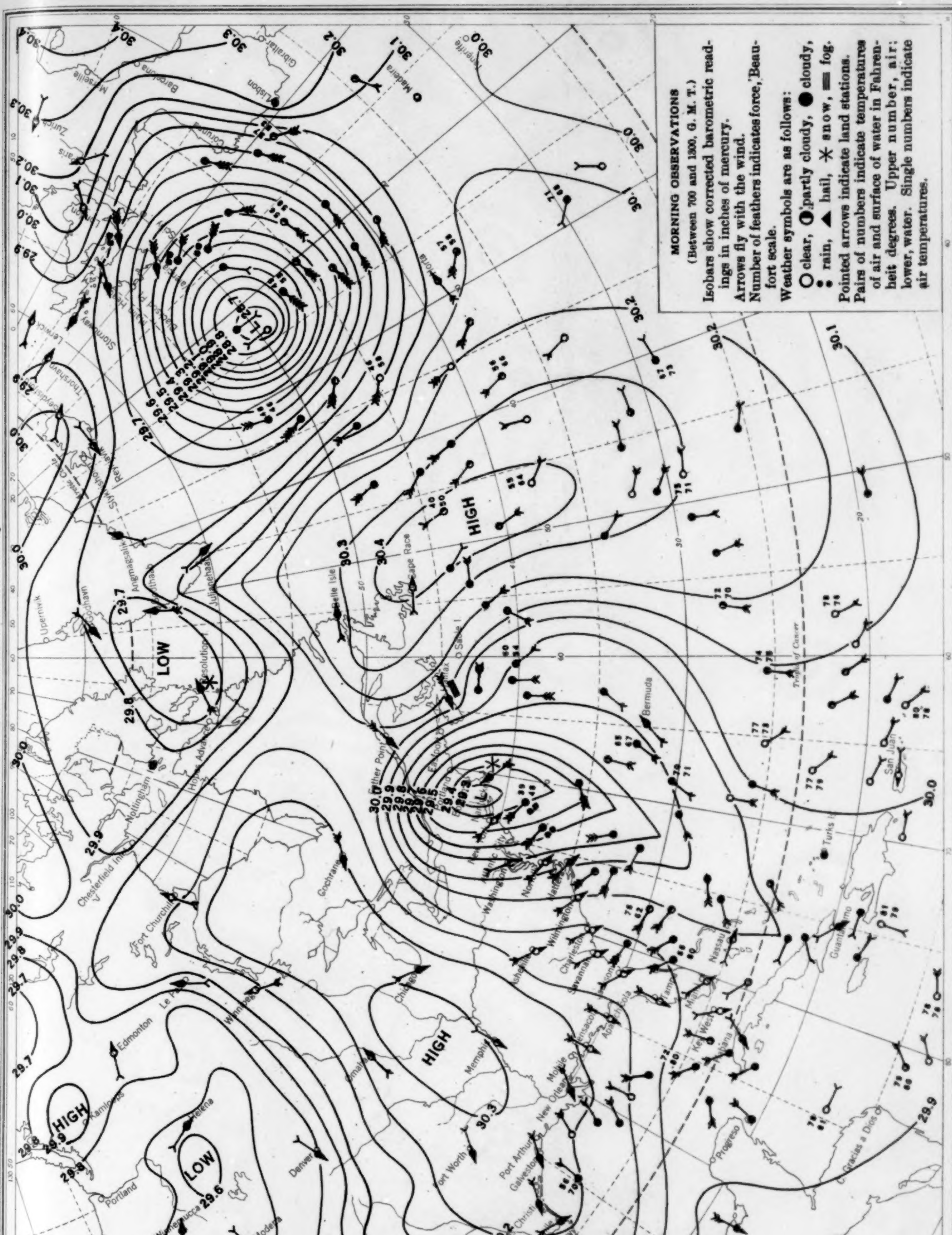


Chart IX. Weather Map of North Atlantic Ocean, March 16, 1937
(Plotted from the Weather Bureau Northern Hemisphere Chart)

Chart X. Weather Map of North Atlantic Ocean, March 26, 1937

(Plotted from the Weather Bureau Northern Hemisphere Chart)